OCTOBER 13, 1960

DESIGN

A PENTON PUBLICATION - BIWEEKLY

Flexible Metal Hose

Contents, Page 3

Ur. Stevens Rice University Microfilms 313 North Pirst Stree Ann Arbor, Michigan

TARHSWORTH



Better bearings begin here in the newly constructed laboratories of Bound Brook's Research and Development Division. Here, with new facilities and modern equipment, Bound Brook's highly specialized talents create new bearing materials, help you develop new product applications. Here, Bound Brook engineers employ unique test equipment to duplicate any conditions, service-test your bearings before they're put in production. If you want to turn your problems into new ideas, new designs, new bearing applications ... turn to Bound Brook!

BOUND BROOK

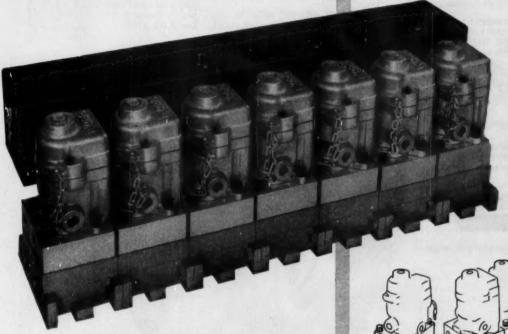
Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Pioneer in Powder Metallurgy Bearings and Parts. Plants at Bound Brook, N.J. and Sturgis, Mich.

Now manifold any number of ROSS 4-way PACER valves with new

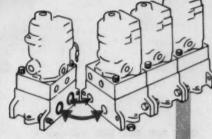


Attach PACER 4-way valve to manifold box with just two cap screws. All air connections are automatically made.

SINGLE STATION MANIFOLDS



PACER is the solenoid valve from ROSS that is capable of 1000 cpm, and more, has all JIC features and is built for super long life. Although this valve requires just seven watts of holding power, its minimum internal orifice is a full $\frac{1}{32}$ inch. Now you may put together as many of these fine valves as you desire with just one air supply and one electrical connection to serve all valves, using this new building-block manifold. Call your Ross representative or write for bulletin 322.



Couple boxes just by butting them together and securing with two bolts. O-rings at the ports make air connections tight automatically.



OPERATING VALVE COMPANY

109 E. GOLDEN GATE . DETROIT, MICHIGAN





When selecting roller bearing pillow blocks, remember

it's what's inside that counts!

MAXIMUM SIZE AND NUMBER OF ROLLERS for highest capacity



CENTRIFUGALLY CAST, PRECISION MACHINED BRONZE RETAINERS for smooth, quiet operation



HIGH, HEAVY INNER RING FLANGES for ease of installation and removal



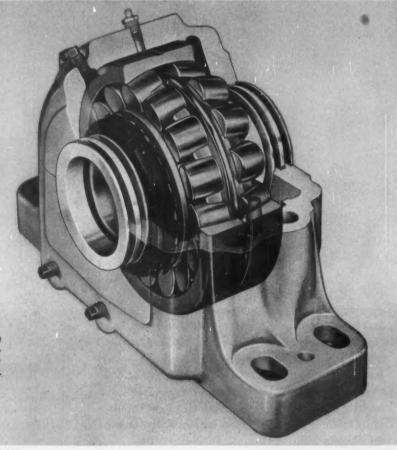
AND INSIDE LINK-BELT ROLLER BEAR-ING BLOCKS you'll find Link-Belt's new spherical roller bearings . . . with big, mirror-smooth, highest capacity rollers; centrifugally cast, precision machined bronze retainers; heavy, broad-shouldered inner rings. All the best features of modern bearing design compactly unitized for utmost economy and long service life.

Link-Belt spherical roller bearing pillow blocks are self-aligning. Available in adapter mounting and directshaft mounting types for shafts from 11/16" to 12". Choice of two effective seals: all-purpose steel, multi-labyrinth seals, or Dacron-contact seals. For full details,

For full details, call your nearest Link-Belt office. Look under BEAR-INGS in the yellow pages of your telephone directory. Ask for Book 2760.



SERIES 8800, 6900, 7800, 7900 have exceptionally rugged, two piece housings—machined as two perfectly matched parts providing easy installating.





LINK BELT
SELF-ALIGNING BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities Export Office, New York 7; Australia, Marrickville (Sydney) Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

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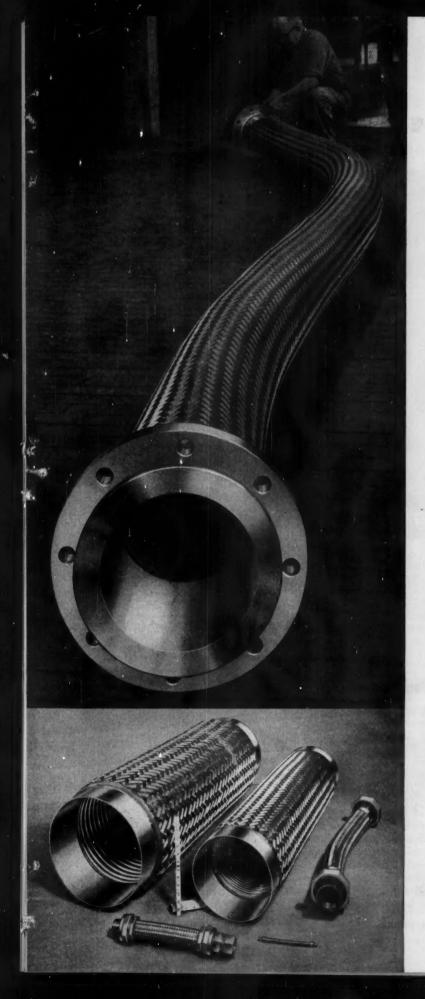
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BIG OR SMALL

FLEXIBLE TUBING ANSWERS TO TOUGH PROBLEMS

The flexible metal tubing assemblies on this page give an indication of the scope of facilities at Anaconda Metal Hose for designing and manufacturing tubing answers to tough problems.

The big 16½-foot, 8-inch diameter tube in stainless steel at the left was built for handling liquid oxygen in missile ground handling equipment. In the photo below, left rear, are two stainless steel connector assemblies—14-inch and 10-inch I.D.—also used in handling liquid oxygen.

From such assemblies down to the tiny ½-inch I.D. Vibration Eliminator shown in the foreground at the bottom of the page, the variety of flexible hose assemblies—in size, material, and design—is almost infinite.

FREE TECHNICAL SERVICE. Anaconda Metal Hose specialists are constantly working with design engineers on special flexible connectors and hose to meet new problems. Having broad experience working in stainless steel, other steel alloys, Monel, copper alloys, aluminum, and Teflon,* they can save you considerable time and money in designing the flexible connector best suited for your needs.

Our specialists are available to you through Anaconda Metal Hose representatives in leading cities — see listing "Hose-Metal" in the Yellow Pages. Or write: Anaconda Metal Hose, P. O. Box 791, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

*Registered trademark for Du Pont fluorocarbon resin

ANACONDA® METAL HOSE

Circle 406 on Page 19

DESIGN

ENGINEERING NEWS



In Space . . . Heat Removal by Endless Belt

Lighter by two-thirds than comparable tube and fin radiators, a unique encless-belt heat exchanger is being studied as a means of dissipating waste heat in nuclear-powered space vehicles. Scientists at North American Aviation's Rocketdyne Div. have calculated that application of the radical new concept to a 300-kw space reactor would involve a total belt-span of about 80 ft, an over-all weight of 800 lb (vs.

1800 lb for a conventional radiator). At launch, the belt, or belts, would be wrapped around the power-conversion capsule and enclosed in a disposal aerodynamic shield. When the vehicle reached its orbital flight path, the belt would unfold automatically and begin revolving around the outer surface of the capsule. Rotational speed could be preset to maintain a constant temperature in the system.

Electronic "Skewer" Monitors Body Oxygen

Palo Alto, Calif. — Medical engineering chalked up another significant achievement early this month with the introduction of a new instrument which makes it possible, for the first time, to measure oxygen directly in the human body.

The new device consists of a platinum-tipped electrode, incorporated in a medical instrument called the Physiological Gas Analyzer. Designed by Beckman Instruments Inc., Palo Alto, Calif., the tiny electrode can be inserted into blood vessels, body fluid reservoirs, or even the brain. Once inserted, it records di-

rect oxygen readings. Conventional techniques require withdrawal of samples for oxygen measurement.

According to Beckman spokesmen, the analyzer is expected to find its most immediate application in basic medical research. Scientists will be able to take in-the-body measurements of healthy subjects to establish norms, then compare these values with readings taken in situations known to be abnormal. The instrument will also be used in surgery to monitor the amount of oxygen in blood and for prenatal tests related to brain damage in infants.



Oxygen-sensing electrode is contained in the tip of a needle and capped with a thin plastic membrane which permits passage of oxygen. Electric current at tip flows in proportion to oxygen present; amplified current drives meter.

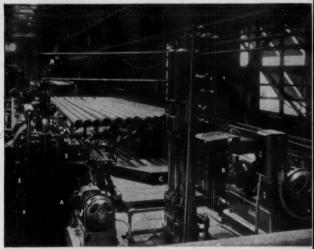
REPORT
NO. 11,803
TEST MORE
PIPE-LONGER
WITH
OILGEAR

From Oilgear Application-Engineering Files

HOW OILGEAR SYSTEM POWERS PIPE TESTER EFFICIENTLY AFTER 23 TROUBLE-FREE YEARS

DATA: To supply power and control system for five functions of a hydrostatic pipe testing machine designed for a wide variety of pipe sizes and testing pressures ranging up to 6000 psi. Linear drives and controls were needed to: 1. Actuate jaw-type clamps to hold and prevent pipe from buckling. 2. Traverse testing head rapidly to and from testing position. 3. Hold testing head against pipe under testing pressures. 4. Actuate "knockout" arms to eject tested pipe from machine. 5. Actuate an intensifier to boost

water used for testing from city pressure to any selected testing pressure up to 6000 psi. Specific Operating Requirements: Simple, safe, dependable; capable of continuous, 'round-the-clock operation, 6 days per week in highly humid atmosphere; cycle rapidly for economical production; require a minimum of maintenance to prevent costly, line-stopping downtime; must be compact to conserve valuable floor space, economical in the use of electrical power.



Hydrostatic Fipe Tester with Oilgeer Application-Engineered Fluid Power System as installed in 1937, and operating continuously since that time. Oilgear "Power-Paks" (A,B), Intensifier (C), Rapid Traverse Testing Head Cylinders (E) are indicated by arrows. Manifold and Control Valves of operator's station (My in drawing) are clearly visible, as are the direct-reading, operating pressure gages on the "Power-Paks." Testing pressures are quickly preset with a small handwheel on "Power-Pak" (B)—not visible. Pipe to be tested rolls directly from pre-testing storage racks, at right, directly into the machine.

solution: An Oilgear Application-Engineered System consisting of two Oilgear Heavy-Duty "Power-Paks," Directional Control Valves, and "Custom-Quality" Cylinders. Each "Power-Pak" uses an Oilgear Heavy-Duty One-Way Variable Displacement Radial Rolling Piston Pump with automatic pressure unloading control to reduce pump stroke when holding a preset pressure indefinitely; eliminate excessive heating and power loss; reduce electrical power input requirements. Oilgear Pumps contain integral auxiliary systems for pilot, supercharge, cooling and filtering . . . with constant pressure and flood self-lubrication, conservatively loaded anti-friction bearings, and large internal passages—mechanical and hydraulic friction is reduced to a minimum for high efficiency . . . virtually guaranteeing a long, trouble-free, maintenance-free life.

USER REPORTED IN 1938—"... after one year of operation we have nothing but the highest praise for the Oilgear Equipment on this pipe tester."

USER REPORTS IN 1960—"This machine has given us years of trouble-free service, operating around the clock six days a week... maintenance has been at a minimum, with occasional changes in intensifier packings, as would be expected in normal operation... performance has been completely satisfactory."

Circle 407 on Page 19

Application-Engineered Fluid Power System
For Hydrostatic Pipe Testing Machine

A Ciliper Power-Put

HOW IT WORKS: Pipe to be tested (P2) rolls from storage rack (X) into cradle of machine between Testing Head (T) and Tail Carriage (D). Testing Head (T) is moved forward quickly by Double-Acting Cylinders (E). Clamping Jaws actuated by Cylinder (G) grip the pipe along its length to prevent buckling. Pipe (P-) is pre-filled with water at city pressure (W). Single-Acting Test Head Holding Cylinders (F) move up in matching pairs—2, 4, 6, 8, 10, or all 12 against Pipe (P-) and Tail Carriage (D). Movement of cylinders (E, F, G, H) are all controlled by valves mounted on Monifold (My) which direct fluid flow from Oilgear "Power-Pet" (B) supplies Pluid Power through Valve (V) to actuate Hydraulic International Cylinders (C2) increasing pressure in Water Cylinders (C1) to any desired pressure up to 5000 psi. After pipe is inspected, intensifier pressure is released, Testing Head (T) is rapidly retracted, and Knockout Cylinder (H) actuates mechanism to eject tested pipe onto rack (Y). Machine is then ready to start a new test cycle.

With Oilgear Heavy-Duty System Components designed for thousands of hours of continuous service at full rated load, savings are compounded with every hour of uninterrupted performance. That's why machinery and equipment manufacturers and their customers say . . . "For the lowest cost per year . . . it's Oilgear!"

For solutions to YOUR linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

1568 WEST PIERCE STREET . MILWAUKEE 4, WISCONSIN

Phone: Mitchell 5-6715 . . . Direct Distance Dialing Code 414

Optical Character Reader

Speeds Up Man-Machine
Information Exchange

TYPED or printed data can now be fed directly into a computer memory without going through a punched-card "middleman." A new optical character reader, the IBM 1418, automatically translates printed documents into machine language—at a rate of 480 characters per sec.

Called a major advance in computer technology by the developer, International Business Machines Corp., the solid-state unit recognizes characters printed by 407, 408, and 409 accounting machines, 1403 printer, and IBM electric typewriters. It also reads elongated type used by credit-card imprinters and can be equipped for mark reading. Input

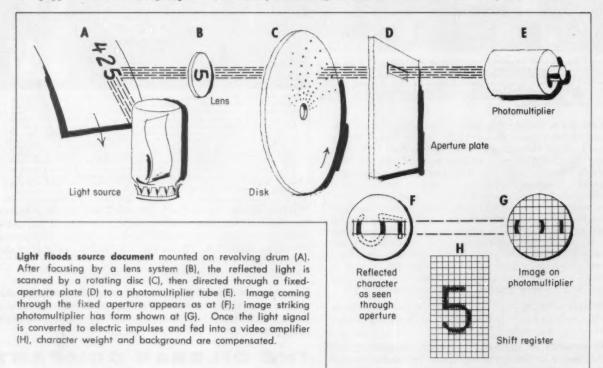


At the reading station, a lamp floods a document with light as it passes over a drum. As an option, the IBM 1418 is equipped with two optical stations, or one optical and one mark-reading station. With the two optical stations, two lines can be read as the document makes one pass through the machine—even if the lines are in different type styles.

cards and papers can run from $5\frac{7}{8}$ to $8\frac{3}{4}$ in. in width and from $2\frac{3}{4}$ to $3\frac{3}{8}$ in. in height.

The scanner is a high-resolution system designed to handle a wide range of print quality. For example, a fixed-aperture plate controls the amount of light coming through, but allows a wider beam to pass than is necessary for sensing a character. This allows the character to be above or below the line of printed information.

Identity of each character is determined by comparing and matching the electric-impulse output from the scanner with internal logic patterns. Numerical characters are individually recognized and transferred to the computer.





MIDVAC STEELS MEET THE MOST CRITICAL DESIGN APPLICATIONS

Where parts for missiles, rockets, aircraft and other jet age products call for super alloys of maximum reliability at temperatures of 1000°F. and over, Midvac Steels offer designers new opportunities of applications.

Midvac Steels, produced by the consumable electrode vacuum arc melting process have these advantages over conventionally produced steels:

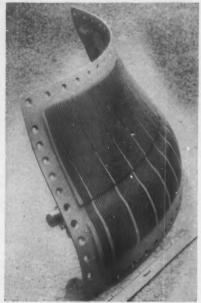
- 1. Improved ingot soundness.
- 2. Reduced ingot segregation.
- 3. Improved chemical homogeneity.
- Refined cast structures—less forging reduction necessary.
- 5. Improved cleanliness.
- 6. Gas content reduced to a minimum.
- 7. Improved workability.
- Improvement in room temperature properties fatigue, impact, transverse ductility, etc.
- Improvement in elevated temperature properties hot fatigue and stress rupture.
- Consistent higher quality product—less customer rejections.

Midvac Steels are offered in many alloys as billets or forgings to meet the most critical design specifications. Complete details on Midvac Steels, plus comparative analysis of leading super alloys are available in new Midvac Steel Booklet. Write for your copy to . . .

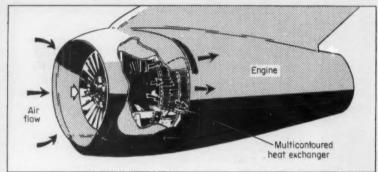
MIDVALE-HEPPENSTALL COMPANY

Nicetown, Philadelphia 40, Pa.
Subsidiary of Heppenstall Company, Pittsburgh, Pa.

Shapely Heat Exchanger for the 707



Unlimited freedom of form in heat exchangers is promised by production techniques developed by AiResearch Mfg. Div., Garrett Corp., Los Angeles. First use of multicontoured surface-heat exchangers is for cooling engine oil in Boeing's 707 turbofan engine. Unlike previous cylindrical or rectangular exchangers, the new coolers require no air scoops or special ductwork. Aluminum oil fins and back-up plates are brazed together; air-flow fins are milled.



Arc Spot Welds Aluminum

New "Metallurgical Riveting" Process Beats Old Problems

New York—Consistently high quality spot welds can be performed on aluminum as a result of more than two years of study by Olin Mathieson Chemical Corp. Where application is suitable, the new technique will lead to faster production, substantial labor and equipment savings, and improved product appearance, as compared with riveting or resistance welding.

Technical procedures and test data for the improved method, made available to interested manufacturers, point up the necessity for close control of electrode feed speed, voltage characteristics, and current time.

Some advantages cited by the company are:

- High-speed fabrication; one operator can make 12 welds per min.
- Reduced labor; no holes to be punched and lined up.
- Low skill requirements; ordinary welders can operate the gun.
- No pre-cleaning; base metal need not be de-scaled; as for resistance welding.

- Low first cost; portable, compact equipment is available as "off-theshelf" items.
- Improved appearance; welds are made from one side only, leaving the other side smooth. No distortion of the base metal occurs.
- High-strength joints; fatigue and corrosion properties equal or exceed those of riveting or resistance welding.

Disadvantages of the method are few. So far, it can only be used on material over 0.03 in. thick, and it is unsuitable for aluminum in the 2000 and 7000 series. When thicknesses are unequal, welds must be made from the lighter to the heavier metal.

The new process is expected to find use in the boat and truck fabricating industries; electronics manufacturers will also be interested.



Aluminum boat ribs are joined to hull "planks" with the MIG spot welding process. Welding gun, as big as an electric hand drill, maintains a direct-current, reverse-polarity arc between aluminum-wire electrode and the workpiece in an argon atmosphere. When the trigger is depressed, a series of relays and timers establishes the arc and maintains it long enough to fuse the two pieces—about ½ sec.



Special Alloy Ball Bearings keep Butterfly Valve modulating at 900° F.!

CUSTOMER PROBLEM:

Require highly heat-resistant ball bearings for butterfly valve which modulates 900° F. hot air blast in turbine air bleed. Despite radial loads up to 300 lbs., shaft must turn effortlessly through 65°.

SOLUTION:

New Departure Sales Engineers, cooperating with Stratos, manufacturer of the auxiliary power turbine, recommended N/D's special aircraft ball bearing of cast cobalt base alloy for this critical application. These bearings were selected for their ability to withstand extremely high temperatures without deterioration.

Extensive testing proved that this N/D equipped modulating system, currently used on the Lockheed Hercules C-130A, military transport, operates at required standards of performance and reliability... and without lubrication! In addition, other New Departure ball bearings, selected for their unsurpassed reliability, are used to support the turbine main shaft which operates at 45,000 rpm.

If you're looking for bearings that operate efficiently at unusually high temperatures and speeds, contact your local N/D Sales Engineer. For additional information call or write New Departure Division, General Motors Corporation, Bristol, Connecticut.



NEW DEPARTURE

BALL BEARINGS

proved reliability you can build around

High-Speed Artwork—Electrostatically

Newton, Mass.—Tubes that translate electronic signals into printed words and pictures on paper are expected to be in demand for everything from label printing to checking fingerprints.

They resemble flattened cathode ray tubes with wire stubble across their face. Varying cathode ray beam currents from within the tube charge the tiny wires electrostatically, and the charges are deposited on paper as it brushes against them.

Four versions of the tube have been introduced by Raytheon Co.: Two 3-in. tubes designed specially for label-writing; two 10-in. tubes designed to reproduce electronically stored information on full-page sheets.

Applications for the tubes include high-speed printing of pictures transmitted over telephone wires (present news service machines take up to seven minutes per picture), and label writing for a national magazine (2 million different labels in an eight-hour day, or 18 times faster than the present system). Other applications are foreseen for business with branch operations, for sending waybills, bills of lading, detailed handwritten statements, or for comparing signatures on checks.



Electrostatic tube "paints" pictures at the rate of three a second; "bristles" of 0.001-in. wire spaced 250 to the inch form the brush. Pictures produced in this manner have a resolution equaling those of a magazine illustration.

Super Ceramic Shows Its Strength



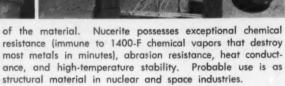
Doused with icy water after heating to 1250 F, a new ceram-

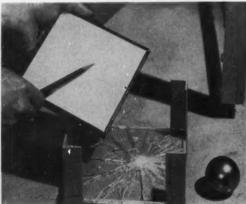
ic-metal composite developed by Pfaudler Permutit Inc.,

Rochester, N. Y. is completely unharmed. The plate shows

no signs of oxidation. Falling-ball test that shatters a 3/8-in.

sheet of safety glass leaves only a faint mark on the surface



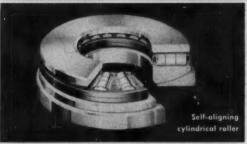


When performance counts-

YOUR TRUST TORRINGTON **THRUST BEARINGS**

Torrington offers these basic types of thrust bearings.













Whatever your performance requirements, there's a Torrington Thrust Bearing precision engineered to meet your needs.

Cylindrical, self-aligning cylindrical, tapered . . . grooved race ball, angular contact ball or needle thrust -all are designed and manufactured to the highest Torrington standards for performance, reliability and long trouble-free service life.

From the smallest to the largest-for power tools or giant radar installations-Torrington Thrust Bearings have the same unmatched precision quality built into every Torrington product. Depending on specific types and applications, they are available with a choice of bronze, steel or phenolic retainers.

Whether your thrust application calls for a standard bearing or one specially designed to meet unique conditions, you can rely on Torrington for a bearing that's exactly right for the job. Contact Torringtondesigners, engineers and manufacturers of every basic type of anti-friction bearing.

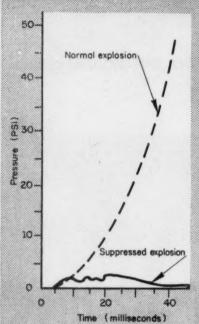
progress through precision

TORRINGTON BEAR

TORRINGTON COM

South Bend 21, Indiana, Torrington, Conn.





Pressure Buildup Triggers Fast-Acting Suppressor

FUTURE disasters will be nipped in the bud by a new explosionquenching system developed by Fenwal Inc., Ashland, Mass. Able to detect an explosion before it really gets started, the equipment reacts in milliseconds to snuff out the blast before it becomes destructive.

Already proved in several installations, the system can be tailored for application in almost every type of industry. While its main function is to cool and envelop an explosion with a blanket of mist, different plants have different protection needs. So Fenwal engineers have allowed for a combination of secondary actions:

• It can open a path to the atmos-

phere for controlled pressure relief.

• It can discharge protective mist in remote areas, preventing secondary fires and explosions.

• It can close valves and isolate the danger area.

 It can automatically shut down a plant or process.

All operations can be accomplished in the time interval between ignition of the blast and build up of pressure.

Split-Second Detection

Heart of the system is an explosion detector. Either a pressure or radiation-sensitive device, the unit senses ignition and sends out an electric signal. Pressure detectors can be set to respond to rate of pressure rise, absolute pressure, or both. Radiation detectors sense selected wavelengths that exist only in a flame.

Protection devices consist of sup-

pressors, isolation valves, and vents. All are operated by fast-acting explosive detonators similar to electric blasting caps.

Suppressors, easily ruptured containers or high-rate-discharge bottles, dispense high-velocity liquid particles. When the explosion is cooled and enveloped in this mist, further combustion is impossible: Five cu cm of water are enough to suppress an explosion in a one-gallon volume.

Vents, unlike rupture disks, open before pressures build up. They consist of special glass windows which are fractured by the detonator mounted against the outside face. Isolation valves, on the other hand, are normally held open by a hollow metal link that contains a detonator. When the detonator "fires" the link breaks, allowing a spring to slam the valve shut and hold it in that position.



Detector, isolation valve, suppressor, and venting device (left to right) all activate automatically at the start of an explosion. Detector senses the danger, then detonates the protection equipment into operation. Because response speed is ultrahigh, pressures and flame fronts never have a chance to become destructive.

During a normal explosion, pressure increases fast—sometimes to thousands of psi within 0.1 sec. Tests show that although buildup starts out at the usual rate, the Fenwal suppressor equipment takes over in the first few milliseconds and pressures rarely get above 3 psi.





Detector operates

Time: Pressure:

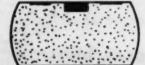
Pressure:

35 Millisec 0,20 psig

0.00 psig



Suppression commences
Time: 40 Millisec
Pressure: 0.55 psig



Suppression complete
Time: 60 Millisec
Pressure: 2.00 psig

DRAFTING TO THE REST TRENDS



In a typical application of the POST Diazo Materials Selector Chart, a draftsman, supervisor and reproduction specialist solve a special print-making problem in short order.

Solve unusual reproduction problems with new Diazo Selector Chart

Keeping up with rapid developments in graphic reproduction and communication techniques is a difficult job these days, even for the experts.

From the engineer's and draftsman's point of view, it's largely a matter of sorting out the specific information which helps him do a better job.

The new Post Diazo Materials Selector Chart does just that—provides a condensed, tabular reference piece that helps you anticipate the ideal diazotype prints for various needs before they occur. This convenient chart gives brief information on sensitized papers, intermediates and specialties in terse "what, when, why and where" style.

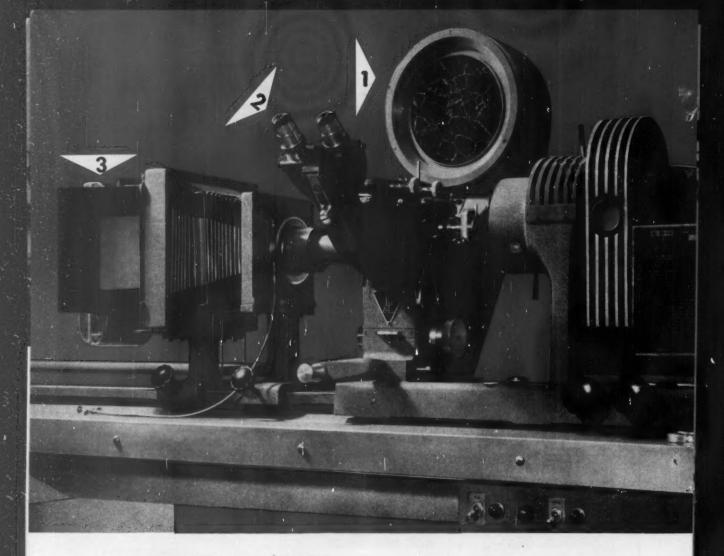
If you're concerned, for instance, with print distribution to different departments, units or groups, then prints on a variety of colored stocks might be the answer.

Increasing print production from diazo equipment with a lower-power light source . . . making legible prints from worn old tracings . . . even making copies from an opaque print . . . all can be handled by use of new Post 206M-14, a fast, extrasensitive whiteprint paper.

Suppose a design conference calls for a poster, actual size, made from a large engineering drawing, rigid enough for display, tough enough for extreme handling and on-thespot sketches? Post diazo-sensitized cardstock in 32 or 50 lb. weight can turn the trick on standard reproduction equipment, ammonia process or semi-moist. For many more helpful solutions to similar situations, ask for your personal file-size copy, of the Post Selector Chart, available from your Post dealer or Frederick Post Company, 3652 North Avondale Avenue, Chicago 18, Illinois.



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Reader Information Service

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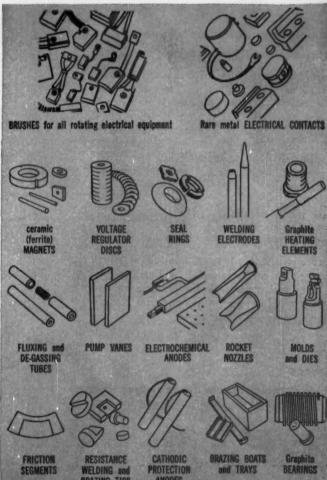
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Carbon, its crystalline kin, graphite, and various metal powders are the raw materials of Stackpole Research—a specialized branch of powder blending and molding aimed at developing new uses and improved manufacturing techniques for "Everything in Carbon but Diamonds."

Here, one of many new instruments in the expanded Stackpole Research Laboratories—a nitrogen absorption analyzer—measures powder surface areas as part of a program to develop economical new techniques for milling carbon powders.

STACKPOLE CARRIES CONFANT

TRENDS

measure of progress: B.S. in metrology

First U. S. degree program in the science of measurement will be established as part of George Washington University's School of Engineering next winter. Necessary because researchers now have to devise too many of their own techniques, the Institute of Measurement Science will fill one of the most troublesome gaps in American know-how. Electronic and space industries (which suffer most from the measurement pinch) have offered equipment, money, and their own employees as students. First classes will include fundamentals of metrology, statistics in measurements, and speciality courses, such as thermal and optical techniques.

scientists nettled by Needles

Latest proposal for a space-communications satellite involves a sort of shredded version of Project Echo. The plan: To orbit two satellites—one around the poles, the other around the equator—both of which would eject a trail of tiny resonant dipoles. In time, the billion-odd strips of tin alloy would settle into the wide rings around the earth, form a permanent reflector for radio messages. Called Project Needles, the proposal is not being well received by most of the world's leading space scientists. They fear that it might compomise the effectiveness of radio telescopes and interfere with signals from our own deep space probes.

good that the ill wind blows

Some U. S. electronics designers are pleased that Japanese transistor radios sell so well. Electronic Transistors Corp., North Bergen, N. J., will make a complete line of transistors designed as replacements for the Japanese imports. Previously, service technicians were forced to resort to trial-and-error methods of repair—and often no suitable component was available.

at ARDC: aardvarks to zebras

Air Force scientists needn't be embarrassed because they're studying bats, beetles, or bobolinks, says Brig. Gen. B. G. Holzman, vice commander of the Research Division, ARDC. He suggests, in fact, that research with such animals (not to mention blind fish, waltzing mice, deaf cats, eels, ants, locusts, lizards, newts, spiders, and toads) has provided the AF with clues on how nature has solved her control and communications problems through two billion years of evolution. Reporting on progress in the Sept. 23 Science ("Birds, Bees, and Ballistic Beasts"), Gen. Holzman says that man-made versions of animal sensory organs can have wide military, civilian, and humanitarian application.

"trimester" gets a college try

In an experiment at the University of Pittsburgh, students may attend classes during three 15-week terms. They do as much work—and get as much credit—in this trimester year as a semester student does in a year-and-a-half. Backers of the system claim to have solved the colleges' overcrowding problems. Critics are charging that it "destroys the maturing aspects of college life," and that it "accelerates students by killing the faculty." Some 35 per cent of a university's budget is independent of the length of the college year.

needed: tougher computer problems

Computer problems assigned to engineering students are too easy, don't offer enough of a challenge, says Professor Donald L. Katz, University of Michigan. During the last year, the computer was a regular classroom tool for about 60 U-M courses, and the experiment showed better teaching methods are needed. The best problems for computer instruction have not yet been found; changes in mathematics courses (oriented toward computer methods) will be necessary. In addition, instructors need plenty of practice in programing and solving problems before they are able to provide leadership for the students.

status quo for consultants

Last-ditch efforts by consulting engineers failed recently when the National Council of State Boards of Engineering Examiners revised its model law but did not restrict engineering by corporations. Consulting Engineering Council and American Institute of Consulting Engineers were attempting to limit engineering to firms managed and directed by registered professional engineers. But the revised law allows states to use the services from any registered professional engineer, regardless of whether he is acting as an agent, employee, or officer of his company.

machinery control sparks electronic design

Manufacturers of electronic components are eyeing the machinery-control field as a new target for specially designed products. According to Bernard M. Goldstein, president, Nytronics Inc., the specific needs of automated machines and process controls will be considered in a new line of components. Transformers, available later this year, will offer constant output, low voltage, high current, and stability. While these characteristics are not the usual electronic-industry needs, they are ideally suited to automation applications. In addition, the characteristics are within capabilities of standard transformers now in production.

the '61 cars:

Growth of the Compacts



CADILLAC: Lubed for life

ON the tested theory that in numbers there is strength, the automobile industry is now up to its assembly lines in compact cars. True to many predictions made last year—when Falcon, Corvair, and Valiant were introduced as economy cars—the compacts, as a class, are beginning to display certain

characteristics of their full-size cousins. Several models introduced this year are larger and plushier than the three pioneers, and they offer as many tempting optional accessories (including air conditioning) as do the industry's luxury cars. The field has also been invaded by four-barrel carburetors—at least two differ-

ent power ratings are offered in most compacts and one model, Lark, is now available with a 220-hp engine. Details, outlined on the following pages, conclude Machine Design's roundup of the '61 cars.

GM

Cadillac: Engineering change has



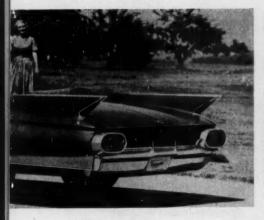
BUICK SPECIAL, OLDS F-85: Strong family resemblance



GM's aluminum V-8 engine: Iron sleeves, cast in the aluminum block, are mechanically locked in place.

PONTIAC: Narrower Wide-Track







CHEVROLET, CORVAIR: Something for everyone

been keyed to passenger comfort in GM's top car. Chassis and frame have been modified to lower the floor, give more chair height; the dogleg in front has been eliminated; and rear doors are 6 in. wider for easier entry and exit.

A lubrication-free chassis (17 fittings have been eliminated) is new this year. In some instances, metal-to-metal joints that required lubrication have been replaced with plastic or rubber bushings; at other points, sealed joints are packed for life with a "special" lubricant.

Single exhaust system and optional nonslip differential are other mechanical changes. Most models are 3 in. shorter than last year's; engine specifications remain the same.

Buick: The new Special, Buick's entry in the compact contest, "looks exactly like what it is—a small Buick, even to the traditional ventiports." Despite this description by the car's designers, Special's family resemblance is only skin deep.

Weighing 2700 lb, the car is 1600 lb lighter than conventional Buicks; its aluminum V-8 engine has one of the highest power-to-weight ratios in the industry; and the new air-cooled torque converter, designed especially for Special, is



LINCOLN CONTINENTAL: Return of the four-door convertible



THUNDERBIRD: Stronger windows



MERCURY: 2-D suspension



RAMBLER: Ten-year face lift

probably the least complicated automatic transmission in the industry.

Significant mechanical changes have also been made in the regular Buick line. The torque tube has been replaced by an open driveline, necessitating complete redesign of the rear suspension system. Driving forces, previously transferred from the rear wheels to the chassis through the tube, are now taken up by a pair of lower control links which connect the frame and the lower axle housing. Coil-springs are still used, front and rear.

Oldsmobile: Like Buick's Special, the New Olds F-85 is a deluxe compact designed to combine economy with performance. It shares the same basic engine with Buick—the 215 cu in. aluminum V-8—and has unit-body construction. Compared

to full-size Oldsmobiles, F-85 is 2 ft shorter than the "88" and weighs 1500 lb less (2695 lb vs. 4150 lb). It will be built in two body styles, four-door sedan and four-door station wagon.

Full-size Oldsmobiles are 3 to 5 in. shorter and $3\frac{1}{2}$ in. narrower this year in keeping with an industry trend toward compactness. Hydramatic transmission has been redesigned to incorporate a torque multiplier as first gear in place of the fluid-coupling, planetary-gear arrangement. Modification of front suspension has reduced the number of grease fittings from 12 to 4.

Pontiac: The famous "wide track" has been reduced 1.5 in. to accommodate an over-all width reduction of 2½ in. Length of most models has been cut 3 in. Pontiac's wide range of powerplants is continued

in '61: The basic engine is rated anywhere from 215 to 348 hp.

Chevrolet and Corvair: Although heavily restyled, Chevrolet retains approximately the same basic dimensions as last year. Engine specifications are unchanged.

Corvair, in the meantime, has expanded into a full line of automobiles, including three ½-ton commercial vans, a utility vehicle (the Greenbrier), and a conventional station wagon. All models use Corvair's rear-mounted, air-cooled engine with transaxle. Dimensions of the passenger cars are unchanged. Engine torque has been boosted by increasing displacement to 145 cu in., and a manual choke replaces the original automatic unit.

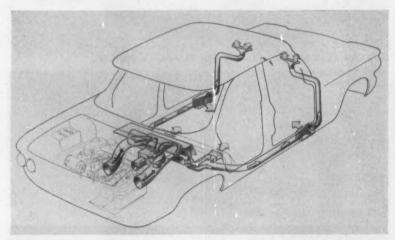
FORD

Lincoln: The first four-door convertible in more than 20 years will be produced by Lincoln in '61. The exclusive model incorporates a number of innovations, including rear windows that automatically retract (backward) 6 in. when either rear door is opened, return to their normal position when doors are closed. The top retracts into the trunk, which in turn opens toward the rear.

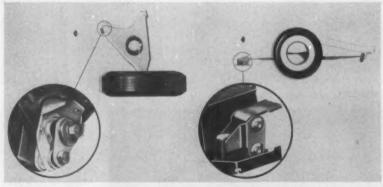
Lincoln has instituted a new final testing procedure for all models that includes a "black-light" search for fluid leaks and a 12-mile road test before cars leave the factory. Like Ford, Lincoln is prelubricated at the factory . . . good for 30,000 miles.

Thunderbird: Completely restyled, Thunderbird has gained an extra 10 in. in "greenhouse" length and 900 sq in. of additional glass area. Doors and quarter windows are fitted with tempered plate glass, curved to follow the contour of the body line. According to T-Bird's designers, the plate glass has better optical qualities than laminated sheet, plus greater impact resistance and structural strength. The fact that it is curved "adds to shoulder room."

Other changes for '61 include a "dual-unitized" body (made in two sections; joined at the dash prior to final assembly), and a steering wheel that slides to the right 10 in. for easier entry and exit. Basic dimensions are largely unchanged.



Corvair's new perimeter heater: Hot air from the engine enters a blender and circulates via ducts to front and rear-seat outlets and windshield defrosters.



Mercury's "cushion-link" suspension permits wheels to move rearward as well as upward. In the front (left), upper pivot pin allows normal vertical movement; lower pin permits rearward action. In the rear (below), tension shackle at the front mount of the spring permits rearward movement of the wheel.

Standard engine is the 300-hp version that was optional last year.

Mercury: Aiming at the low-price field, Mercury, for the first time in its history, is available with a sixcylinder powerplant (Ford's 223 cu in. engine). The '61 models are 41/2 in. shorter and 11/2 in. narrower than last year's. Wheelbase has been cut 6 in. A brand new suspension geometry, used exclusively by Mercury, permits each wheel to move rearward as well as upward. And another first for Mercury is a vacuum-actuated (by the engine) litter collector. This unusual accessory consists of a glass jar mounted in a sliding drawer in the center of the instrument panel. Closing the drawer triggers the vacuum system, which packs all litter in the drawer tightly into the jar.

A-M

Rambler American: For the first time since its introduction more than 10 years ago, the American has been completely restyled. Still mounted on a 100-in. wheelbase, the car is 5.2 in. shorter and 3 in. narrower than last year, but interior dimensions have not been disturbed. A convertible has been added to the line—the second U. S. compact with this body style.

Standard equipment for '61 includes a ceramic-coated exhaust system guaranteed to the original owner for as long as he owns the

Classic Six and V-8: A major engineering achievement, wrapped up in the '61 Rambler, is the new sixcylinder engine with a die-cast aluminum block. More than six years in the design-development stage, the block is the first to be produced in the U.S. by the die-cast method. Fitted with centrifugally-cast dry liners, the engine weighs 80 lb less than Rambler's 1960 cast-iron powerplant, has the same displacement (195.6 cu in.) and power rating (127 hp). Liners are bonded to the aluminum block by the BMI technique (bimetallic interlock bond) developed by Doehler-Jarvis Div., National Lead Co. Rambler is also completely restyled this year, comes equipped with a ceramic coated exhaust system, and offers, as an option, a vacuum-operated four-door locking system.

A-M's aluminum six: A spectacular achievement in the art of diecasting, the block weighs just 67 lb — 53 lb of aluminum, 14 lb of cast-iron liners. Casting procedure involves the use of nine loose pieces, all automatically loaded into the die.



'61 Engines

Make and Model	Bore & Stroke (in.)	Dis- placement (cu. in.)	Com- pression Ratio	Power, max (bhp)	Torque, max (lb-ft)	Carbure tion
CADILLAC	4.00 x 3.87	390	10.5:1	325 @ 4800	430 @ 3100	4b
BUICK						
Special	3.50 x 2.80	215	8.8:1	155 @ 4600	220 @ 2400	2b
LeSabre (standard)	4.12 x 3.40	364	10.25:1	250 @ 4400	384 @ 2400	2b
(optional)	4.12 x 3.40	364	9:1	235 @ 4400	375 @ 2400	2b
Invicta, Electra	4.19 x 3.64	401	10.25:1	325 @ 4400	445 @ 2800	4b
OLDSMOBILE	2.20 0.00					
F-85	3.50 x 2.80	215	8.75:1	155 @ 4800	210 @ 3200	2b
88	4.13 x 3.69	394	8.75:1	250 @ 4400	405 @ 2400	2b
Super 88, 98	4.13 x 3.69	394	10:1	325 @ 4600	435 @ 2800	4b
	1.10 A 0.00	991	20.2	020 9 1000	200 0 2000	
PONTIAC	4 00 - 0 00	000	0.0.1	215 @ 3600	390 @ 2000	2b
Catalina, Ventura	4.06 x 3.75	389 389	8.6:1 8.6:1	235 @ 3600	402 @ 2000	4b
Star Chief, B'ville	4.06 x 3.75	389	8.6:1	230 @ 4000	380 @ 2000	2b
Options			10.25:1	267 @ 4200	405 @ 2400	2b
			10.25:1	283 @ 4400	413 @ 2800	2b
			10.25:1	287 @ 4400	417 @ 2400	4b
			10.75:1	318 @ 4600	430 @ 3200	3-2b
			10.75:1	333 @ 4800	425 @ 2800	4b
			10.75:1	348 @ 4800	430 @ 3200	3-2b
CHEVROLET			10.10.1	919 6 1000	200 @ 0200	0-20
V-8 options	3.87 x 3.00	283	8.5:1	170 @ 4200	275 @ 2200	2b
A-9 obtions	3.01 A 3.00	200	9.5:1	230 @ 4800	300 @ 3000	4b
	4.12 x 3.25	348	9.5:1	250 @ 4400	355 @ 2800	4b
	1.12 A 3.20	919	9.5:1	280 @ 4800	355 @ 3200	3-2b
			11:1	305 @ 5600	350 @ 3600	4b
			11.25:1	320 @ 5600	358 @ 3600	4b
			11.25:1	335 @ 5800	362 @ 3600	3-2b
Six cylinder	3.56 x 3.94	235.5	8.25:1	135 @ 4000	217 @ 2000	1b
The second secon	3.44 x 2.60	145	8:1			1b
CORVAIR						
THUNDERBIRD	4.05 x 3.78	390	9.6:1	300 @ 4600	427 @ 2800	4b
LINCOLN	4.30 x 3.70	430	10:1	300 @ 4100	465 @ 2000	2b
TERCURY	3.75 x 3.30	292	8.8:1	175 @ 4200	270 @ 2200	2b
Options	4.00 x 3.50	352	8.8:1	220 @ 4400	336 @ 2400	2b
Opions	4.05 x 3.78	390	9.6:1	300 @ 4600	427 @ 2800	4b
Six cylinder	3.62 x 3.60	223	8.4:1	135 @ 4000	200 @ 2000	1b
RAMBLER						
American	3.13 x 4.25	195.6	8:1	90 @ 3800	160 @ 1600	1b
American	3.13 x 4.25	195.6	8.7:1	125 @ 4200	180 @ 1600	1b
Classic Six	3.13 x 4.25	195.6	8.7:1	127 @ 4200	180 @ 1600	1b
Canada Gra	3.13 x 4.25	195.6	8.7:1	138 @ 4500	185 @ 1800	2b
Classic V-8	3.50 x 3.25	250	8.7:1	200 @ 4900	245 @ 2500	2b
CIMBRIC V-D	3.50 x 3.25	250	8.7:1	215 @ 4900	260 @ 2500	4b
Amhassador	4.00 x 3.25	327	8.7:1	250 @ 4700	340 @ 2600	2b
A Comment of the Comm	4.00 x 3.25	327	9.7:1	270 @ 4700	360 @ 2600	4b
ARK						
Six cylinder	3.00 x 4.00	169.6	8.5:1	112 @ 4500	154 @ 2000	1b
V-8 options	3.56 x 3.25	259.2	8.8:1	180 @ 4500	260 @ 2800	2b
· o opinion	3.56 x 3.25	259.2	8.8:1	195 @ 4500	265 @ 3000	4b
	3.56 x 3.62	289	8.8:1	210 @ 4500	300 @ 2800	2b
	3.56 x 3.62	289	8.8:1	220 @ 4500	305 @ 3000	4b

'61 Sizes

Make and Model	Wheelbase (in.)	Length (in.)	Width (in.)	Height* (in.)	F/R (in.)
CADILLAC	129.5	222	79.8	56.3	******
BUICK Special LeSabre Invieta, Electra	112 123 126.3	188 217.9 220.9	71.3 80 80	52.5 57.2 57.5	56-56 56-56 62-61
OLDSMOBILE F-85 88 98	112 123 126	188.2 212 218	71.5 77.2 77.2	52.5 55.8 56.6	56-56 61-61 61-61
PONTIAC Catalina, Ventura Star Chief, B'ville	119 123	210 217	78.2 78.2	55.8 55.8	62.5-62.5 62.5-62.5
CHEVROLET	119	209.3	78.4	55.5	60.3-59.3
CORVAIR	108	180	67	51.5	34-54
THUNDERBIRD	113	205	75.9	52.5	61-60
LINCOLN	123	212.4	78.6	53.5	******
MERCURY	120	214.6	79.1	55	EE-80
EAMBLER American Classic Ambassador	100 108 117	173 189.8 199	70 72.4 73.6	56.2 57.3 56.9	54.6-53 58.7-59.1 57.7-59.1
LARK Cruiser	108.5 113	175 179	71.4 71.4	56.5 56.5	57.4-56.6 57.4-56.6

*With full design load.

For resistance to impact...





THE Great Horned Owl represents one of Nature's most rugged designs. Standing over two feet high with a four- to five-foot wingspread, he dives headlong from full flight into fields, underbrush, crops and hedgerows to capture rodents.

This fearless friend of the farmer is built to withstand tremendous impact as his head, wings, legs and feet hit the ground and foliage.

If the heads, feet, brackets or bases of your machinery are subject to frequent or occasional impact loads, they will perform better and withstand more shock if fabricated from steel. So, cut down on guarantee claims, improve customer satisfaction, and build even higher your company's reputation for fine machinery by designing for fabricated and welded steel.

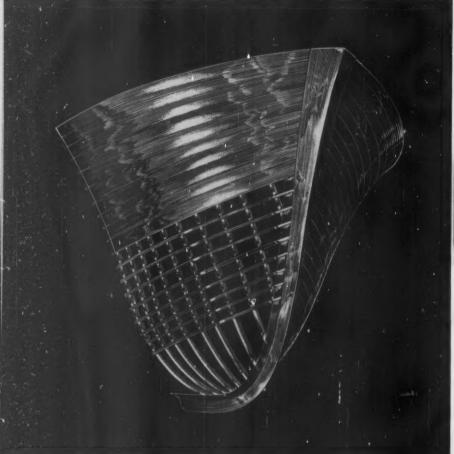
Your LINCOLN Field Engineer will not design your products for you, but with his broad background in welded fabrication, he can give you many helpful and cost-saving ideas.

THE LINCOLN ELECTRIC COMPANY

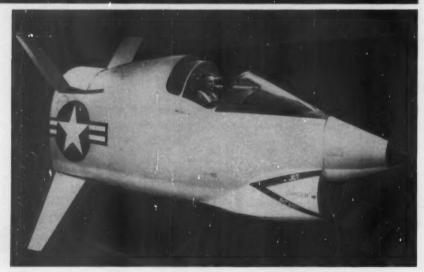
Dept. 2040 · Cleveland 17, Ohio



Planks of aluminum, assembled in the same manner as wooden ones, make a new type of hull for pleasure craft. Aluminum strakes are fastened to aluminum rib frames and Geon seam stringers with stainless-steel, self-tapping screws and locknuts. A synthetic compound caulks the joints. Besides the obvious advantages of aluminum's light weight, durability, and resistance to the elements, this new hull offers ease of repair. If a plank or rib is damaged, a new one can be ordered by number and installed with a screwdriver and a small wrench. Avro Aircraft Ltd. is building the hulls for United Marine Inc.



PICTURE REPORT



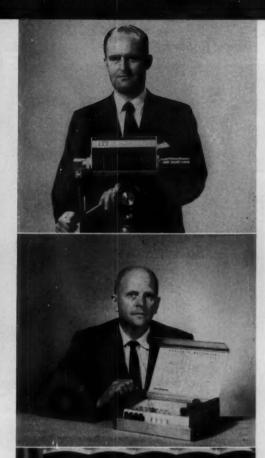
Nose section becomes escape capsule in a Chance Vought design for the Navy. In an emergency, the pilot jettisons the tail section and opens stabilization fins and parachute. This mock-up was constructed from an F8U-1 jet fighter. The system would add about 600 lb to the Crusader. Present ejection-seat systems weigh less than this, but Chance Vought engineers say future ones will be heavier.



Double-wall construction for spacecraft is being investigated as "particularly promising" by designers at the Aeronutronic Div. of Ford Motor Co. Besides shielding against solar and cosmic radiation and meteoritic impacts, the double wall could circulate gasses to maintain a habitable environment inside. Artist's conception shows space station and winged re-entry possibilities, as well as compartmentation to permit sealing off a section in the event of meteorite damage.



Cat's eyes for the dogface are upgraded by an infrared gun sight developed by Raytheon Co. This "sniperscope" permits a rifleman to see farther in the dark and gives him a target image twice as big as a similar sight used in World War II. It weighs 13 pounds, compared to the old 28-pounder, and operates from a power supply which hooks on the user's cartridge belt. The receiver portion only can be used, with infrared light supplied by a central searchlight, to afford protection from enemy detectors.





Three industrial designers will receive awards from Aluminum Co. of America for outstanding achievement in designing with aluminum. Alcoa Industrial Design Awards will be presented Oct. 27, during the American Society of Industrial Designers national convention.

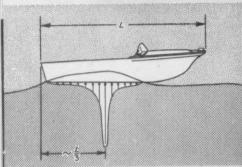
Channing Wallace Gilson, a consultant designer, is to be cited for his redesign of a closed-circuit television camera for International Telephone & Telegraph Co. An aluminum extrusion, cradling the vacuum tube, serves as a heat sink. Elimination of external cooling apparatus permits reduction of the camera's size.

Tor Petterson, a design counselor, was commissioned to redesign a Voltron wattmeter for ease of use and maintenance. Top and bottom sections are interlocking aluminum extrusions which join at a continuous hinge.

Robert A. Gelert, staff designer for Arcadia Metal Products, designed a modular shading system consisting of two-blade aluminum cells which are adjustable as to shape, tilt, width, opening, and row spacing.

News Report:







Planing in calm water puts a surprisingly high local pressure on a small boat hull. Precise strain measurements in vital areas are obtained in the laboratory using a load that produces the same pressure distribution. Competition among small-boat makers is turning them more and more to the test lab for verification of designs.

Dry-Land Shakedown

SMALL boats, built to traditional hull forms for centuries, are undoubtedly seaworthy. The boating boom, however, got underway with an armada of small craft built on stylized lines-often from new and untried materials, with little attention to structural soundness. To improve competitive positions, and to satisfy the crowd of increasingly knowledgeable Sunday yachtsmen, leading manufacturers of glass-fiber boats are refining their product through extensive development programs. Full-scale materials-research is getting underway, and hulls are being designed on strict engineering principles.

End of guess and test

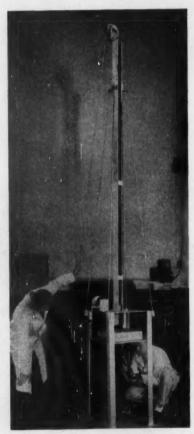
Builders of the Arkansas Traveler (Traveler Mfg. Div., Stanray Corp., Little Rock, Ark.) aim high; they're striving for complete laboratory pre-evaluation of hull structures wherever possible. This is in marked contrast to pre-boom methods of testing a hull by operating it for undefined periods over as rough water as can be found.

Testing in the water is still an indispensable step in any hull-evaluation program. But some characteristics were inevitably overlooked when this was the sole means of testing. Reliable prediction of fatigue life, for instance, was impossible.

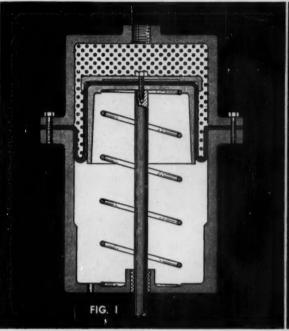
Four-point program

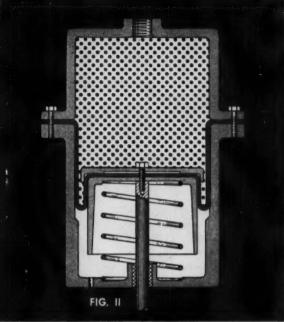
Basis of laboratory testing at Traveler is a four-point program designed to correlate simplified dryland beatings with the worst conditions encountered afloat:

 Static loading — boat planing in the steady state



Pounding a slab of hull material, researchers simulate effect of boat striking a submerged log. After impact, rate at which water flows through the damaged section must not exceed a predetermined amount. Results of this test show remarkable correlation with actual hull behavior.





For Hydraulic and Pneumatic Devices

Nothing rolls like a Bello Rolling Diaphragm. It's frictionless!

The Bellofram Rolling Diaphragm provides ultrasensitive response in hydraulic or pneumatic devices where frictionless, long-stroke action in small diameter configurations is required . . . and where flex life of millions of cycles is necessary.

These desiderata are achieved through the rolling action of a flexible, thin-sidewall diaphragm consisting of a high-tenacity fabric overlay embedded in elastomeric material.

Fig. I shows how Bellofram Rolling Diaphragm conforms to the piston. Fig. II shows how, as the piston descends under pressure, the Bellofram Rolling Diaphragm rolls off the piston's sidewall and onto the cylinder's sidewall in a smooth, continuous, frictionless movement.

The Bellofram principle can be applied widely in actuators, pumps, instruments, seals, accumulators, and fluid dampers.

Which of these advantages are you looking for?

To the designer confronted with sit-uations for which conventional bellows, O-rings, or cup packings are inadequate, Bellofram Rolling Diaphragm offers a constellation of advantages found in no other product:

- 1. Friction-free (low hysteresis).

- 2. No break-out friction effects.
 3. Non-perous and leakproof.
 4. Constant area in all piston positions.
 5. Almost infinite flex life (millions of cycles).
- 6. Sensitivity to extremely small pressure changes.
- No mechanical spring gradient.
- 8. Compatibility with practically all environmental gases or fluids.
- Automatic de-icing action.
- 10. Free positioning with complete relaxation at any point in the stroke.
- 11. Does not require close machine finish tolerances on pistons and cylinders.
- 12. Freedom from abrasive wear.
- 13. One hundred stock sizes. Four mount-

ing configurations. Special types and sizes designed to order.

14. Excellent temperature stability from
—85°F. to 550°F. (from —120°F. to
700°F. in some cases). Wide range of working pressures: 1 inch H₂O to 500 psi (up to 1200 psi in some cases). Effective pressure areas from .028 to 108 square inches. Cylinder bore diameters from .25 to 12 inches. Extended range of stroke (.01 to

SEND FOR FREE LITERATURE

Bellotram Rolling Diaphragms are protected by U.S.A. and foreign patents.

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Fatigue testing machine loads hull hydraulically with three or four times the static load, up to 2 cps rates. During the test, regular checks are made on deterioration of the structure, location and progress of cracks, and the sequence in which they occur. Interpretation of the test can so far be made only on a comparative basis, but it is nevertheless considered a very valuable test in the series.

- Fatigue loading boat planing over rough water
- Distributed transient loading boat striking a sandbar
- Local impact boat striking a sharp rock

Tests simulating these conditions range from slamming sandbags into the hulls, to strain gaging the parts of a hull subject to static pressure.

Building a test

Small-boat builders like Traveler, with no code to help them, build their laboratory test programs from lessons learned afloat. The first step is to determine hull deflection. In one elementary method, a scratch gage traces a pattern showing magnitudes of deflections at various points on the hull. These data provide the basis for further dry-land tests.

Next, a static-loading test is set up. Loads that duplicate scratchgage deflections are placed on the planing contact area of the hull, and brittle lacquer results are noted. Strain gages are then applied to high stress areas, and actual stresses found for static loading, fatigue loading, and other cases of interest.

How hard to hit it

Impact resistance of a hull structure is evaluated through drop-tests, first on an actual hull, and after correlating factors are set up, on small sections of hull material. One method of determining damage due to impact is to measure leakage through the damaged section. Impact energy vs. leakage-rate curves give a measure of operating performance. Other impact tests may be used; one of the most dramatic is the pendulum test, in which a sharp spike backed by several hundred

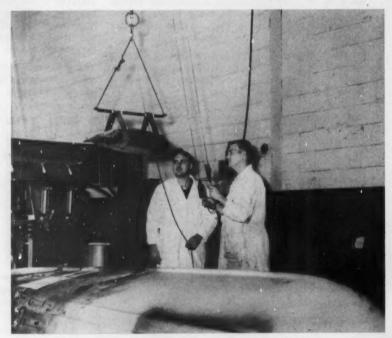


pounds weight is swung at the boat's bow.

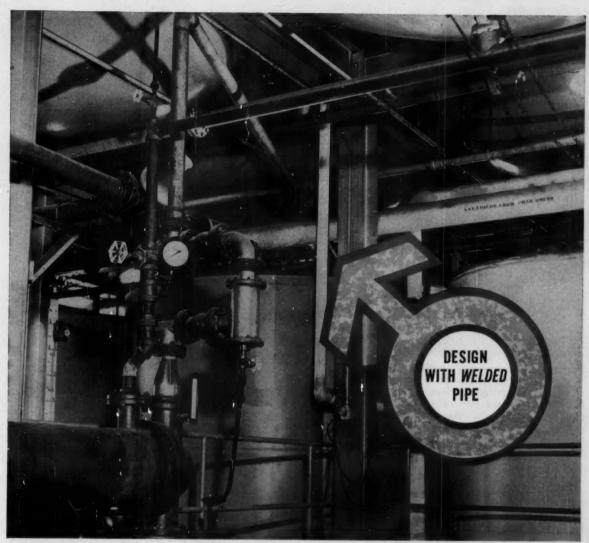
For safer Sundays

While it is generally accepted that laboratory tests do not duplicate all conditions afloat, they do provide essential pointers. Weathering and abrasion tests, for example, have led to winter storage recommendations.

Although manufacturers are reluctant to disclose their research findings, it is likely that designers will soon draw up their plans from universal boat-hull specifications. As one company puts it, "We make it mighty hard for the Sunday sailor to take a bath."



Driving into a sandbar is simulated with the drop test at the location of the planing wedge. Boat builders point out that this is far different from a local impact test, since the sand itself takes up some of the impact energy in deforming. Strain-gage readings are in good agreement with theoretical computed strains for limber hulls—not so good agreement for very stiff hulls.



LC-606

WELDED STAINLESS PIPING WINS

on "killer" duty in Southern Sugar Refinery

Corrosive liquors piped over long distances in this sugar refinery service—often at temperatures of from 180°F to 220°F—played havoc with non-ferrous metal piping. Down times occurred two or three times a year for pipe replacement and costs climbed accordingly . . until welded stainless pipe entered the picture. Now, with Type 347 stainless on the job the problem is solved.

Frequent down times are eliminated, thanks to the alloy's superior corrosion resistance, and as an important bonus, freedom from product contamination is achieved.

• Why not check into the profit possibilities of modern welded steel piping in your own operation? Ask for helpful Bulletin 8591—and consult a quality welded steel pipe producer in your district.

Welded Steel Tube Institute, Inc.

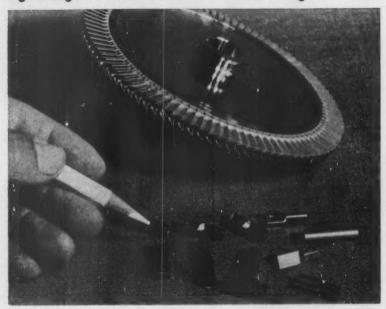
1601-G Hanna Building, Cleveland 15, Ohio

Armco Steel Corp. • The Babcock & Wilcox Co., Tubular Products Div. • The Carpetter Steel Co., Alloy Tube Div. • Clayton Mark & Co. • Damascus Tube Co. • Jones & Laughlin Steel Corp., Electricweld Tube Div. • National Tube Div., United States Steel Corp. • Ohio Seamless Tube Div. of Copperweld Steel Co. • Republic



Steel Corp., Steel and Tubes Div. • Revere Copper and Brass Inc., Rome Manufacturing Company Div. • Sawhill Tubular Products, Inc. • Southeastern Meta?s Co. • The Standard Tube Co. • Superior Tube Co. • Trent Tube Co., Subs. Crucible Steel Co. of America • Union Steel Corp. • Van Huffel Tube Corp. • Wall Tube & Meta! Products Co.

Lightweight Buckets Shave Turbine Weight



Development of sheet-metal buckets for an advanced turbine fuel pump led to a weight-saving of over 50 per cent. Low inertia of the rotating assembly also simplified control mechanisms, further reducing weight and costs. General Electric Co. designed the new pump for North American's B-70 Mach-3 intercontinental bomber. The wheel operates at 1000 F for up to 1000 hr without maintenance. Buckets can be pinned, brazed, or welded as required to meet operating conditions, GE reports. Further development is needed, however, before twisted or tapered buckets can be specified.

Thermoelectricity Advance Reported by Bell

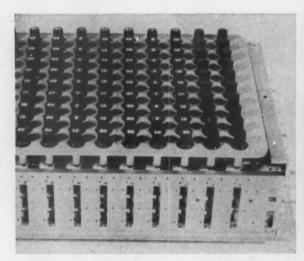
Prague, Czechoslovakia—The International Conference on Semiconductors has been informed of the discovery of a thermoelectric material which may be far more efficient than any other.

Many compounds and alloys have been studied in laboratories around the world; the best to date is silver antimony telluride, synthesized by Dr. J. H. Wernide of the Bell Telephone Laboratories, New York.

Silver antimony telluvide (AgSb-Te2) is a p-type element, most efficient in the 200-500 C range, with a thermoelectric figure of merit (Z) of about 1.75 times 10 - 3 per deg C in this temperature range. The alloy has a very low thermal conductivity, about 1/100th that of germanium.

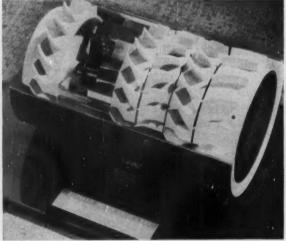
Synthesis of the alloys involves direct fusion of stoichiometric quantities of the desired elements. Pure samples are then extracted by zonerefining techniques.

The search for improved materials at Bell centered on ternary intermetallic semiconductors.



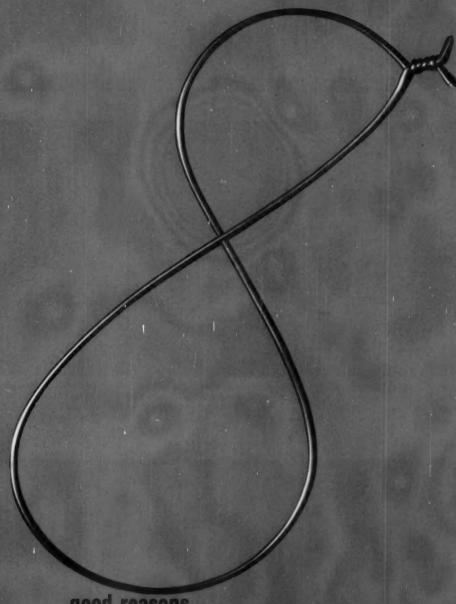
Pushbuttons Oust the Patchcord

Pushbutton crossbar switch, designed to replace the traditional patchcord switch or large matrices of individual switches, will handle a microvalt dc signal or a kilovolt ac. James Cunningham, Son and Co. Inc., Rochester, N. Y., claims number and complexity of circuits that can be set up at one time is unlimited. Any circuit, closed by pushing a button, may be maintained by twisting the button a quarter turn. Resistance of the contact is about 10 milliohms.



Silence Comes in Three Stages

Three aerodynamic stages, plus lightweight rotors, boost performance of a new fan to a high level. Low-speed axial-flow machine runs at 3375 rpm, has a blade tip speed of only 81 ft per sec. Designed by AiResearch Mfg. Div., Garrett Corp., the fan has an unusually low noise level. Static pressure rise is 3.2 in. of water at a flow rate of 120 cu ft per min. Two-pole motor operates from a three-phase, 60 cycle supply and draws 0.6 amps per phase.



good reasons
why it pays to specify
American Steel & Wire
for all of your
stainless steel wire needs



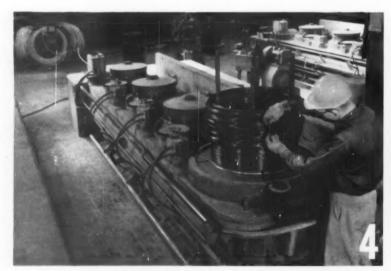
good reasons why it pays to specify American Steel



By using modern welding techniques, we can turn out continuous coil weights as heavy as 500 pounds to suit your particular needs. Heavier coil weights reduce down time on your machines, speed handling of material.



The latest in controlled annealing methods enable us to produce uniform properties in stainless wire that assure consistent performance on your equipment and in your product.



To insure the gage of your stainless is consistent from end to end, it's checked constantly during the continuous drawing process. ASW's wide range of modern, precision drawing machines can turn out everything you need in type, size and finish.



After drawing, the wire is again inspected to make certain that the gage and finish are exactly as specified.



& Wire for all of your stainless steel wire needs



Up-to-date salt and acid bath techniques and equipment guarantee the smooth, clean wire surface so important to the finished quality of your product. After cleaning, coatings such as this electrolytic copper coating are often applied to make your job of fabrication easier.



During processing and at finished size, our stainless wire is tested for tensile strength and other properties to make sure it meets specifications. Such tight control insures quality.



To insure supply and fast delivery, we stock 300 to 400 tons of cold heading stainless wire in addition to a heavy tonnage of other stainless steel wire items at all times.

Our stainless steel wire service is second to none. In addition to our regular salesmen, we have special Stainless Steel representatives in your area who have both engineering and mill backgrounds. They know metals, they know production. Their assistance can be invaluable to you in solving the really tough ones. Call your nearest ASW Sales Office today. If you like, we'll have a man out to see you at your convenience. Or if you prefer, write American Steel & Wire, Dept.0388, 614 Superior Avenue, N.W., Cleveland 13, Ohio.



American Steel & Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors United States Steel Export Company, New York

Satellites by the Dozen

Orbiting Relay Stations

May Break Overseas

Communications Jam

A PERMANENT "busy signal" is threatening global telephone communication. The bottleneck is no mystery to experts at Bell Telephone Laboratories: Underseas circuits—overwhelmed by a crescendo of voice traffic from the world's 130 million telephones—are almost obsolete.

There are now 71 million telephones in the U. S., 62 million more in the rest of the world—and the number is increasing rapidly. More than 2600 voice channels connect New York and Chicago, says Frederick R. Kappel, president, American Telephone and Telegraph Co., yet only 57 link the U. S. with England, and only 8 with Italy. Bell experts see a promising longrange solution: Ring the earth with a team of randomly orbiting satellites.*

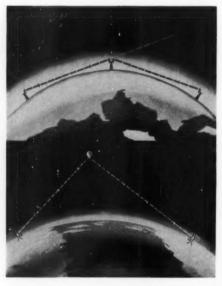
Case for the Satellites

Broadband microwave radio systems can handle nearly 11,000 conversations, and satellites will accept broadband communications. One satellite system could provide at least 500 to 1000 channels, maybe



Fewer than 400 telephone voiceways exist between continents today, including both cable and microwave systems. And while available facilities will soon be supplemented by new channels, demand will still exceed capabilities. A team of 30 satellites such as the one shown in a polar orbit might, by itself, do a better job. Estimates vary, but the experts agree such a system could provide from 500 to 1000 world-wide channels 24 hr a day.

Relay towers spaced about 25 miles apart catch and send on microwave transmissions in present systems. If the beams were not intercepted they would shoot off on a tangent to the earth. By replacing the towers with satellites, Bell Telephone engineers hope to come up with systems to span entire continents and oceans without expensive and power-consuming multirelay systems.



^{*}More details on the communication-satellite program are presented in the September Issue of Bell Telephone Laboratories' Reporter.



Dow Corning

SILICONE NEWS

for design and development engineers . No. 78

Keeps Your Feet Dry

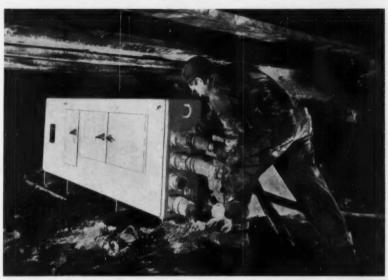
Shoe Saver[®], the water repellent that protects and preserves leather footwear, is one very popular member of the silicone family.

"Field" engineers swear by it for hunting boots and golf shoes. "Domestic" engineers marvel at the way it keeps dress shoes soft, comfortable, and new looking longer. "Little League" engineers like the way it keeps shoes from getting soaked through when puddle widths are misgauged.

Use Shoe Saver to protect your family's footwear this fall and winter. Available in spray can or dauber bottle at most sporting goods counters, shoe stores or shoe repair shops.

No. 241





50% MORE POWER

Westinghouse engineers specified silicone insulation in designing the world's largest sealed mine power centers. The reason behind their choice: Silicone insulation makes possible tremendous savings in weight and space.

Westinghouse engineers have made excellent use of the advantage silicone insulation provides . . . to increase capacity of mine power centers without a corresponding increase in size or weight. Constructed for rugged service, the new power centers are better able to meet demand, can readily be skidded from one location to another, and are more easily stored when not in service.

The silicone-insulated power centers deliver nearly 50% more power per pound of transformer than units of comparable size insulated with Class A or B insulating materials. The 600-kva, 7200/480-volt unit is only 42 inches high, the 300-kva unit, only 36 inches. Both units handle increasing loads without sacrificing portability or space vitally important in mining operations.

Silicone insulation helps the power centers withstand the most severe dust and moisture conditions likely to be encountered underground. Sealed in a nitrogenfilled enclosure, the coils are protected against moisture even when de-energized during prolonged shutdowns. The power centers are virtually maintenance-free.

SOLVE SPACE AGE PROBLEMS

How? "With silicones" has been the byword in the aircraft industry for a number of years — and still is. How extensively so is indicated in the new documentary reference, "Silicones Solve Space Age Problems".

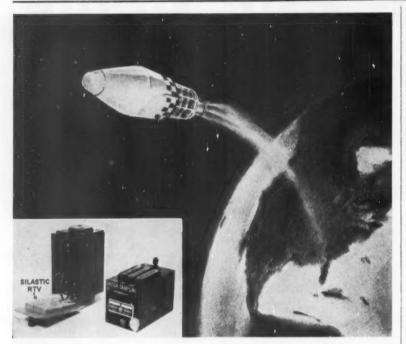
Constant new advances in technology of aeronautics have created more severe performance requirements . . . have stimulated development of new silicones and new applications for established silicones.

Now available, this new bulletin for aeronautical engineers and designers is a compilation of concise case histories that show the wide range of uses of silicones. It suggests possible design changes and solutions to problems through the advantageous use of the different forms of silicones.

Included are histories that cite how Dow Corning Silicones have been (Cont. pg. 2)



Dow Corning SILICONE NEWS Page 2



HOW TO MEET TOUGH SPECS

Missile-making calls for materials and components that will meet the most rigid environmental specifications. That frequently means silicones to engineers at General Devices, Inc., Princeton, N. J.

Here's a good example. Every Discoverer rocket that leaves the ground carries with it General Devices' CM Series Minicom Type Electromechanical Commutators. To assure optimum protection against moisture and vibration, Commutator connector heads are coated with Silastic® RTV, Dow Corning's fluid silicone rubber that vulcanizes at room temperature.

This job-proved "form-in-place" silicone rubber provides components and wiring with more than ample protection against 100% relative humidity for 72 hours or more. It provides a resilient cushion that

tronic high speed switches, multicoders and multiplexers, keyers, power supplies, subcarrier oscillators, telemetering and data logging equipment. No. 243

summarizes the more important properties

enables sensitive parts to withstand 100 G

shocks for 5 milliseconds . . . permits continuous operation despite vibrations of 30

to 50 G's over a frequency range of 25

to 2,000 cps in each of three mutually per-

Silastic RTV readily flows around the most

intricate parts to provide a void-free,

moistureproof seal of high dielectric

strength. Its ease of handling and the

unique properties it provides has led Gen-

eral Devices to make extensive use of

Silastic RTV for component boards and

potted connectors for their multichannel

telemetering equipment. Other Silastic

RTV uses are in their telemetric and elec-

of the different silicones, designates typical applications of each.

pendicular planes.

To obtain your free copy, circle No. 244

new literature and technical data on silicones

Transparent Potting Compound — Dow Corning Dielectric Gel is the silicone potting material that flows as a water-white fluid and cures in place to form a clear, resilient, protective mass that permits both visual and instrument checking of parts within a potted assembly. Retention of outstanding dielectric properties, moisture resistance and serviceability over a wide temperature span are some of the features of this unique potting material described in a four-page, illus-No. 245 trated brochure.

Wire and Cable insulated with Silastic is used to advantage in numerous ways in different

industries. A new, sixpage illustrated brochure details the outstanding electrical properties, serviceability over a temperature span from -90 to 260 C and resistance to the effects of weathering, corona, ozone and nuclear radiation of wire and cable insulated with Silastic . . . cites applica-tions and specifications



ranging from aircraft to commercial building, from shipboard to appliances.

Optical Silicon Reference — Physical properties and transmission characteristics of Dow Corning optical silicon are presented with the aid of a table of typical values and nine full-page graphs. All the features that make optical silicon useful for infrared detection, surveillance and guidance systems are contained in a new multipage technical data sheet.

Something to Consider - Silicone molding compounds produce parts and components having a highly desirable combination of structural and dielectric properties - heat stability, high strength, good retention of insulation value, low moisture absorption, good thermal conductivity, light weight, and resistance to corrosion and fungus attack. Properties and applications are presented in a four-page leaflet. No. 248

Job-proved Dow Corning silicone lubricants help designers solve lubrication problems created by adverse operating conditions. Used on equipment ranging from freezers to core oven conveyors -at temperatures as low as minus 100 F, as high as 500 F. Send for a handy brochure on properties and applications.

SPACE	AGE	PROBLEMS	(Continued)
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used to increase reliability of commercial and military aircraft, of ground support and avionic equipment. A "capsuled" table

SILICONE NEWS is published for design and development engineers by

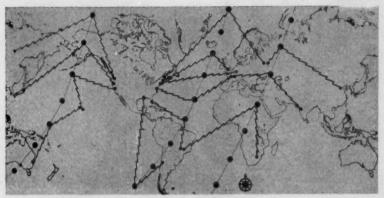
silicones

Dow Corning CORPORATION MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C. CANADA DOW CORNING SILICONES LTD. TORONTO OVERSEAS: DOW CORNING INTERNATIONAL S.A. ZURICH

Dow Corning Corporation, Dept. 4910, Midland, Michigan Pinase send me: 241 242 243 244 245 246 247 248 249 TITLE_ COMPANY_ CITY ZONE STATE

> FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE IN COUPON ABOVE, OR REFERENCE NUMBER ON READER SERVICE CARD



All areas of the world could be linked by one 50-satellite system. random polar orbits at a height of about 3000 miles, active satellites would monitor two-way talks between 26 earth-tied installations. Co-ordination between earth terminals would be necessary to insure that each station beams messages at a different target. The plan assumes that one frequency band 500 megacycles wide can be used for 600 telephone circuits or one television channel in each direction. Each terminal could "see" one satellite at all times.

more. These would be world-wide channels; rather than merely furnishing links to England or Italy, they would provide circuits to all of Europe at the very minimum.

Communication satellites probably still years away. How-ever, if the recent Echo I experiment shows that space balloons have a reasonably long life, Echo systems will be technically feasible for transoceanic communication, says Dr. John R. Pierce, BTL's director of research-communication principles. A commercial grade of service between the U.S. and Europe would require about 30 Echoes in random 2500-mile polar orbits.

Problems Remain

Voice signals reflected from Echo I are very weak-on the order of 10-15 w. This energy is roughly equivalent to that which the eye would pick up from a one-watt flashlight beam originating 10,000 miles out in space.

Bell scientists say they are working for a circuit as good as the best long-distance circuit available today -and perhaps a little better. But lots of research will be necessary before one billionth of one millionth of a watt can be reflected from a balloon and made to apparently originate from about 6 ft away. According to Mr. Kappel, the job is hardly started: "Can we make satellite communication systems work well, and at reasonable cost? The question will only be answered by hard work."

Whether or not Echo I proves practical, it has already furthered techniques and know-how. For example:

- · Tracking problems have been solved.
- · Receivers of unprecedentedly low noise have been designed.
- · FM systems with feedback receivers (tuned frequency of the receiver follows changes in the transmitted frequency as the FM transmitter is modulated) have proved workable.

These advances in the state of the art may pay off in the design

leasons Why **Robbins VALVES Are the Most**

Economical You Can Buy

• The only valves that can be completely serviced in less than 1 minute from the front of mounting panel without removing the valve from the line!



To service a Robbins Metering & Shut-Off Valve it is only necessary to remove the handle, loosen locknut and remove barrel assembly . . . all accomplished from the front of the panel . . . no need to disturb the line connections!

Ze Single barrel assembly!

For both civilian and military installa-tions the single barrel assembly design and construction features (barrel, spindle, spindle seals, barrel seals and seat in one unit, cleaned, lubricated, sealed for oxygen service) mean practically instantaneous renewal of service without disconnecting any plumbing.

3 As many as 5000 cycles before requiring servicing!

Many Robbins Metering Valves in constant use on an 8-hour a day basis for three years . . . have never required servicing, lubrication, or any parts replaced!

... And the Most Reliable!

Precision made and tested. Design capabilities, manufacturing procedures, and quality control operations at Rob-bins Aviation are all directed toward one objective . . . to produce a valve of the highest quality that will provide the user with the greatest reliability and the greatest economy over many years of service.

All Valves LOX Cleaned and Packaged . Ready for Instant Use



Angle • Globe • Three-Port • Manifold



2350 E. 38th St., Los Angeles 58, Calif. LUdlow 9-5221 Circle 418 on Page 19

Windows in the Atmosphere

Earth's atmosphere is transparent to electromagnetic radiation at frequencies below 20,000 magacycles. Up to 200 mc, absorption is negligible, then it builds up (slowly at first, more sharply beyond 6000 mc). At 20,000 mc, absorption on a path toward the horizon is essentially complete; even in a vertical path through the atmosphere, losses are high. At the other end of the "window," the ionosphere passes frequencies above 100 mc. Lower frequencies also get through when conditions are right, but they can't be counted on as more than intermittent, unreliable carriers. Man is stuck with limits of 100 and 20,000 mc for his reliable earth-to-space communication channels.

If you use stainless steel plate



this <u>new booklet</u> on Carlson services in stainless steel gives you worthwhile facts!

This new Carlson Booklet, "Producing Stainless Steels . . . Exclusively," documents a unique, specialized service. Fully illustrated, it includes detailed sections on stainless steel plates, heads, forgings, special shapes, and other stainless products manufactured by Carlson.

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G. O. CARLSON, INC. 142 Mershallton Road THORNDALE, PENNSYLVANIA

I would like a copy of the new Carlson Booklet.

Name	

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City____State__

SATELLITES

Signals from Echo I are weak, so BTL engineers designed a maser receiver with extreme sensitivity. The device is so sensitive that even radio noise due to the earth's heat becomes serious. Because this noise is picked up by side and back lobes of an ordinary parabolic dish antenna, Bell engineers did more designing. The result: A huge horn-reflector antenna that practically eliminates noise from the earth.



of another kind of communication satellite: One that takes a more acitve part in message transmission.

Active vs. Passive

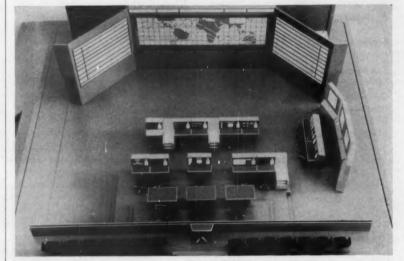
Two kinds of satellites are on BTL's drawing boards: "Active" types would receive, amplify, and rebroadcast signals; "passive" satellites (like Echo) would simply bounce microwave beams back into the atmosphere.

In active systems, ground antennas and transmitters will be

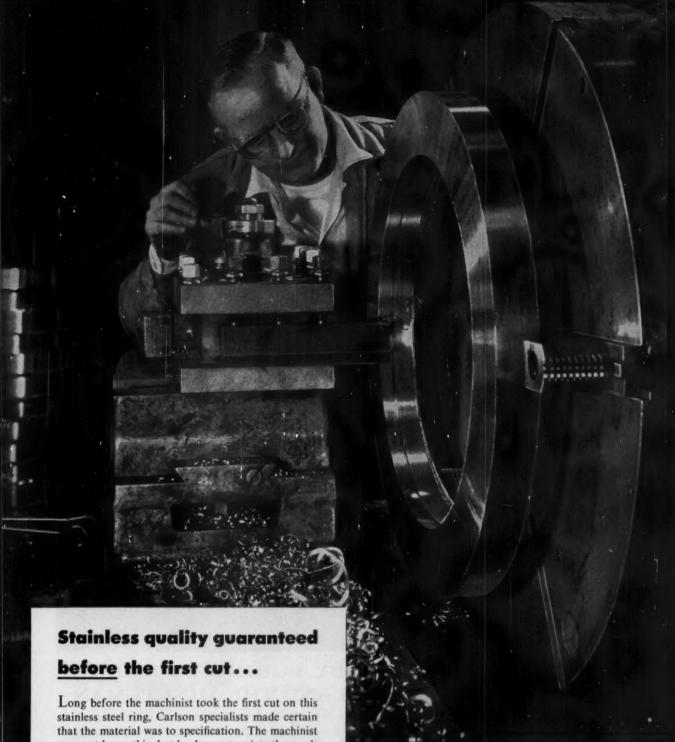
small, but wide frequency bands will be necessary (one band for outgoing signals, another for incoming ones). The only usable frequencies will be those built into the satellites.

Main advantage of passive satellites is their ability to reflect back all signals, regardless of frequency. Three stations, for example, could simultaneously send to one Echo (at different frequencies) and all three messages would be received in a readable form.

For Mercury: A Dozen Back Seat Drivers



Astronauts in Project Mercury's capsule will be helped along in orbit from a control room like this scale model, planned for Cape Canaveral, Fla. Twelve consoles, built by Stromberg Carlson, San Diego, Calif., will display vital information about the flight, the astronaut, and the orbiting capsule to the flight director and his aides. From these data, the NASA Operations Director will manage the flight. Seated at the rear of the room, official observers will watch information displays such as orbit number and status of capsule systems.



may not know this, but he does appreciate the result -the ease of machining to meet the most exacting requirements.

Whether you want rectangular stainless plates, pattern-cut special shapes, or machined products, you will save fabricating time by making full use of Carlson services. Fabricators of chemical, process, nuclear, aircraft and missile equipment recognize the advantages of these services.

Our specialists will be glad to work with you in producing just what you want, delivered on time. Telephone, write or wire for action.

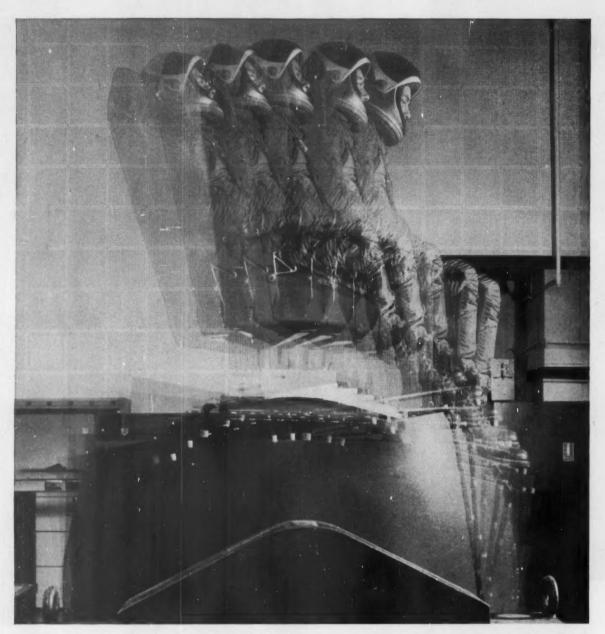
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LING SYSTEMS USED BY BOEING TO SHAKE DOWN HUMAN FACTORS AND THE MINUTEMAN

Two modern Minutemen—man and missile—advance guards of the space-age, have taken this shattering ride on a Ling Shaker. The Boeing Airplane Company, as prime contractor on the Minuteman Program, is making extensive use of its complete Ling Vibration Systems to test assemblies for the solid-propellent ICBM. In other studies related to human factors, Boeing researchers checked out man's resistance to the punishing 28,000 lb. force of a Ling A249 Shaker—one of the few available shakers of sufficient size and force to make the experiment practical. The Ling system used by the Boeing Aero-Space Division for these tests is one of the largest systems ever built for random-sine wave testing. The installation reflects the emphasis Boeing places on vibra-

tion testing as a key factor in reliability. For details on Ling Vibration Systems which can help you to greater testing reliability, please write Dept. MD6 at our Anaheim address.



A DIVISION OF LING-TEMCO ELECTRONICS, INC. . 1515 SOUTH MANCHESTER, ANAHEIM, CALIFORNIA . 120 CROSS STREET, WINCHESTER, MASSACHUSETTS

The shaker used in the experiment shown at the left is only one part of the large vibration testing installation custom-engineered for Boeing Aero-Space Division by Ling Electronics.

Boeing selected the shaker for its impressive size and high force rating of 28,000 pounds—as well as its advanced closed-loop liquid cooling system. This liquid cooled design employs water and dissipates heat so efficiently that very little heat is dumped on the testing site—a distinct advantage.

In addition to the super-sized shaker, Ling supplied all associated electronics for the extensive Boeing installation—including control console, power supply, noise mixer, equalizer-analyzer, auto-servo systems and all the other equipment needed for complete random-sine wave vibration testing.

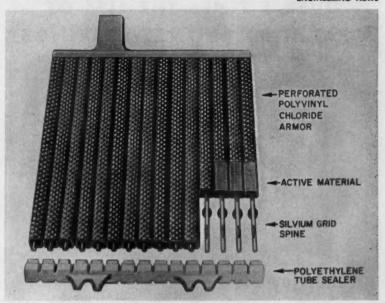


The Boeing installation was specifically designed by Ling Electronics to serve the company's needs. Like all Ling systems, it is the result of close cooperation between Ling and its customer. Whatever your own needs in high power electronics—vibration testing, acoustics or sonar—you'll find that you, too, can rely on Ling for practical design.

LING

ELECTRONICS

HIGH POWER ELECTRONICS FOR VIBRATION TESTING • ACOUSTICS • SONAR



Square Tubes Boost Battery Life

A powerful industrial battery 55 per cent lighter than flat-plate batteries has been announced by Exide Industrial Div., The Electrical Storage Battery Co., Philadelphia. Weight saving, together with up to 64 per cent space-saving, is achieved through the use of a tubular-type positive plate. Called the EHGS Exide-Ironclad, the battery will last more than 20 years in float-charge service for such uses as telephone, emergency lighting and power, and laboratory service.

Meetings and Shows

Oct. 19-

Fluid Power Society. First Annual Meeting to be held at the Hotel Sherman, Chicago. Further information can be obtained from society headquarters, 5595 N. Hollywood Ave., Milwaukee 17, Wis.

Oct. 19-20-

National Society of Professional Engineers. Fall Meeting to be held at the Statler-Hilton Hotel, Denver. Additional information can be obtained from NSPE, 2029 K St., N.W., Washington 6, D. C.

Oct. 20-21-

National Conference on Industrial Hydraul'cs, sponsored by Illinois Institute of Technology, to be held at the Hotel Sherman, Chicago. Further information is available from Illinois Institute of Technology, 35 W. 33rd St., Chicago 16, Ill.

Oct. 24-25-

American Society of Mechanical Engineers - American Institute of Mining, Metallurgical and Petroleum Engineers. Fuels Conference to be held at the Daniel Boone Hotel, Charleston, W. Va. Further information can be obtained from ASME, 29 W. 39th St., New York 18, N. Y.

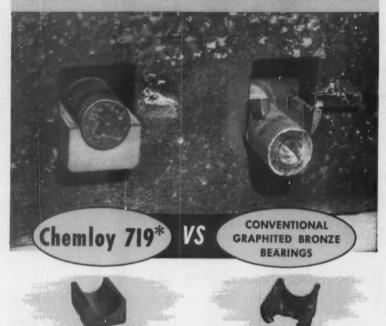
Oct. 25-27-

Society of Automotive Engineers Inc. National Transportation Meeting to be held at the Hotel Leamington, Minneapolis. Additional information is available from SAE, 485 Lexington Ave., New York 17, N. Y.

Oct. 26-28-

American Institute of Electrical Engineers-Institute of Radio Engineers. Fifth Annual Conference on Non-Linear Magnetics and Magnetic Amplifiers to be held at the Bellevue-Stratford Hotel, Philadelphia. Further information can be obtained from AVEE, 33 W. 39th St., New York 18, N. Y.

OVER 5 TIMES THE LIFE OF GRAPHITED BRONZE BEARINGS



This report comes from the insulating board division of a large paper company where Chemloy Dry Bearings are outlasting, outperforming and saving money over conventional graphited bronze bearings. They are used to support rollers turning continuously in kiln dryers where lubrication is not practical or possible. Operating temperature is 350°F., bearing loads approximately 25 psi. Figures based on a 3-year service record indicate a yearly savings of \$6,000.00.

Here are the facts:

- 1. Chemloy Bearings will last more than 8 years, as against an 18 month life expectancy for graphited bronze.
- 2. Chemloy's lower coefficient of friction eliminates retainer strips and weldments required for each bronze bearing installation.
- 3. Reduction of stub shaft wear due to bearing failure.

Plus increased safety to personnel and equipment through elimination of hazardous welding of retainer strips in a dust-laden atmosphere.

Put Chemloy 719 to work for you. Send b/p or specs. for engineering recommendations. Request Bulletin T-120 and price sheet on sheet, rod and tubing.

Crane Packing Company, 6425 Oakton Street, Morton Grove, Ill. (Chicago Suburb). In Canada: Crane Packing Company, Ltd., Hamilton, Ont.

*Best in DuPont Tefton Based Bearing Materials



Chemloy Bearings in action. Weld marks at left show positions of retainers formerly needed to keep bronze bearings in position. 20,000 such weldments are eliminated in this instance.







Oct. 27-28-

American Society of Industrial Designers. Sixteenth Annual Conference to be held at the Edgewater Beach Hotel, Chicago. Further information is available from society headquarters, 15 E. 48th St., New York 17, N. Y.

Oct. 27-29-

Aircraft Electrical Society. Industry Display to be held at the Pan Pacific Auditorium, Los Angeles. Additional information is available from society headquarters, 3540 Wilshire Blvd., Los Angeles, Calif.

Oct. 31-Nov. 2-

National Fluid Power Association. Fall Meeting to be held at the Edgewater Beach Hotel, Chicago. Further information can be obtained from NFPA headquarters, 1618 Orrington Ave., Evanston, Ill.

Oct. 31-Nov. 2-

Society of Automotive Engineers Inc. National Powerplant Meeting to be held at the Hotel Sheraton-Cleveland, Cleveland. Additional information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Nov. 2-4-

Society of Automotive Engineers Inc. National Fuels and Lubricants Meeting to be held at The Mayo, Tulsa, Okla. Further information is available from SAE, 485 Lexington Ave., New York 17, N. Y.

Nov. 14-16-

Steel Founders' Society of America. Annual Technical and Operating Conference to be held at the Hotel Pick-Carter, Cleveland. Further information is available from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

Nov. 14-17-

American Institute of Electrical Engineers-American Institute of Physics. Magnetism and Magnetic Materials Conference to be held at the Hotel New Yorker, New York. Additional information can be obtained from AIEE, 33 W. 39th St., New York 18, N. Y.

Nov. 14-18-

American Society of Tool and Manufacturing Engineers. Western Engineering Conference and Exhibit to be held at the Memorial Sports Arena, Los Angeles. Further information is available from ASTME headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Nov. 16-19-

Society of Naval Architects and Marine Engineers. Annual Meeting to be held at the Waldorf-Astoria Hotel, New York. Additional information can be obtained from society headquarters, 74 Trinity Place, New York 6, N. Y.

Nov. 27-Dec. 2-

American Society of Mechanical Engineers. Winter Annual Meeting to be held at the Statler Hilton Hotel, New York. Further information can be obtained from ASME, 29 W. 39th St., New York 18, N. Y.

Nov. 28-Dec. 2-

Twenty-fourth National Exposition of Power and Mechanical Engineering to be held at the Coliseum, New York. Additional information is available from exposition headquarters, 480 Lexington Ave., New York 17, N. Y.

Dec. 5-8-

National Conference on the Application of Electrical Insulation to be held at the Conrad Hilton Hotel, Chicago. Sponsors are the American Institute of Electrical Engineers and the National Electrical Manufacturers Association. Further in-



"Where have we been running that ad for engineers?"



Your first bonus from Sier-Bath's Tri-Dimensional Service is free consultation with our gear design engineering staff of incomparable ability developed through designing unending thousands of advanced design successes. Your gears and gear units are designed to the most advanced principles of "gearometry," to assure the ONE best gear design for your particular application the first time

Your second bonus is the infallibly accurate

and economical—production of your

gears and gear units by Sier-Bath's skilled gear craftsmen, working with the most advanced, automatic, high-speed production equipment and the most extensive gear testing equipment ever assembled under one roof. Sier-Bath precision gears provide master gear benefits at a fraction of the price.

Your third bonus is the use of our gear experts at your plant or in the field, before and after installation, to assure the advantageous performance and saleability of your units.

Make Sier-Buth your "gear department" for complete service including design, engineering, tooling, production, inspection and dependable field service. You'll save engineering time, get better gears at lower cost and give your machines utmost productive capacity and trouble-free operation.





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Since misalignment is the basic problem that shaft couplings are designed to solve you'll find a published conservative misalignment rating (along with load capacity rating) for every Fast's Coupling. Compare it with the misalignment rating of any other coupling you are considering. One further advantage of Fast's Couplings' misalign-

ment ratings: You save money on installation because, knowing the ratings, you don't have to line up driving and driven elements with pinpoint accuracy. It's one more important reason why Fast's Couplings are the choice of more equipment manufacturers than any other gear-type coupling. KOPPERS COMPANY, INC., 410 Scott Street, Baltimore 3, Md.



FAST'S COUPLINGS

Engineered Products Sold with Service

Circle 423 on Page 19

The Design Equation that Saves You Money...

Use easy-to-install, economical National Retaining Rings to locate and position bearings or parts on pins, shafts and in housings. Eliminate grinding or machining shaft stock to form shoulders. You save time and material and reduce weight and space requirements. Ask for data on your specific application, today!

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= improved design + economy!





ALL TYPES AND FINISHES AVAILABLE—National rings are supplied in square, round and rectangular types of carbon spring steel, bronze, beryllium-copper, stainless steel and aluminum in a wide selection of finishes. Send drawings or sample part for recommendations,

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ENGINEERING NEWS

formation can be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Short Courses and Symposia

Oct. 20-21-

Engineering Institute on the Engineer As an Executive, to be held at the University of Wisconsin. Presentations and discussions will deal with requirements for an engineer to move up to management. Additional information can be obtained from Engineering Institutes, University Extension Div., 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Oct. 20-21-

National Symposium on Hypervelocity Techniques, sponsored by the Institute of the Aerospace Sciences, to be held at the Shirley-Savoy Hotel, Denver. Additional information can be obtained from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Oct. 26-27-

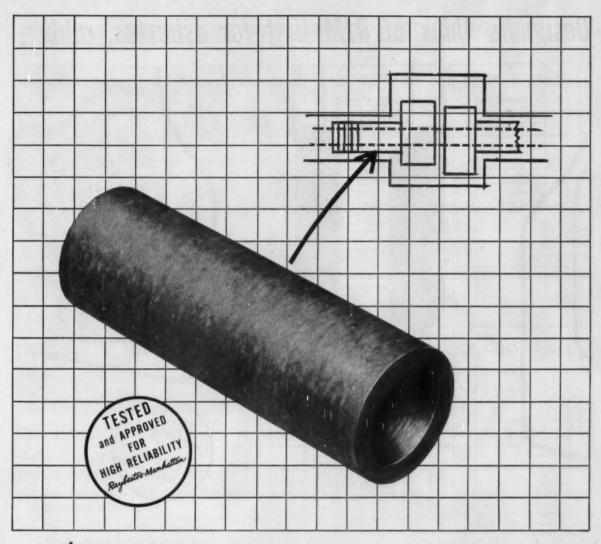
Computer Applications Symposium, sponsored by Armour Research Foundation, to be held at the Morrison Hotel, Chicago. Additional information is available from Andrew Ungar, Conference Program Chairman, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Oct. 27-28-

Engineering Institute on Applications of Magnetodynamics to be held at the University of Wisconsin. Discussions will cover aspects of this new field that apply to engineering. Further information is available from Engineering Institutes, University Extension Div., 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Nov. 15-16-

Symposium on Engineering Applications of Probability and Random Function Theory, sponsored by Purdue University. Further information is available from J. L. Bogdanoff or F. Kozin, Division of Engineering Science, Purdue University, Lafayette, Ind.



R/M CAPABILITY produces

reinforced Teflon* bearing materials

• to lower friction • to resist extrusion • to resist corrosion • to eliminate contaminating lubricants

R/M reinforced Teflon bearing materials are giving excellent service in a wide variety of industries. In the chemical industry, their use has greatly extended the range of chemicals that can be handled by a single pump. In the textile and food industries, they have eliminated the need for lubricants and the resulting contamination of materials in process. And in almost every application, they have lowered replacement costs and maintenance requirements while reducing wear.

Some R/M reinforced Teflon bearing materials can be

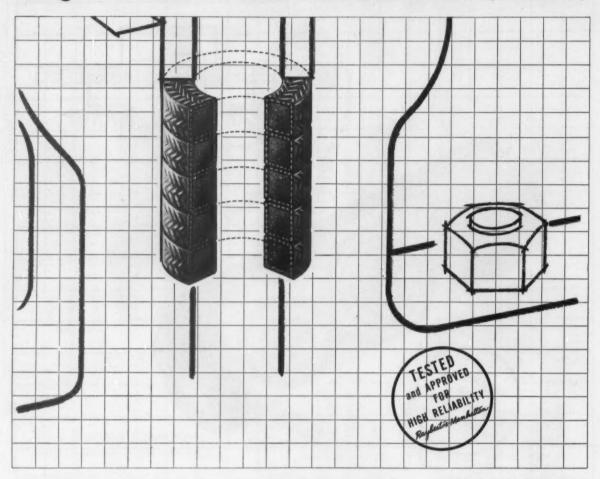
machined to very close tolerances. Others, like R/M RL-742 asbestos-reinforced Teflon bearing material, can be molded to fit your specific requirements. The high rate of thermal expansion and poor flow characteristics of pure Teflon have been greatly reduced with this reinforced material.

If you have a bearing application, particularly where corrosion and high temperatures present a problem, or where normal lubricants cannot be used, R/M reinforced Teflon bearing materials may be the answer. Send data on your application.

*Registered trademark for Du Pont fluorocarbon resins



Designers think of R/M first for asbestos, rubber,



R/M CAPABILITY

develops valve stem packings for temperatures above 1000°F

A good example of R/M capability at work is the development of valve stem packings for service on lines handling superheated steam, hot gases and oils. R/M No. 325—made by braiding AAA grade Inconel wire inserted asbestos yarns over a plastic core—is typical. The core contains pure, long-fiber asbestos, graphite and other ingredients. All organic materials which tend to carbonize and become a solid mass at high temperatures have been eliminated. This reduces volume loss to a minimum and also reduces adjustments.

An inhibitor—compounded into the packing—combats corrosion encountered after valves are hydrostatically tested and stored. Corrosion resistors are also incorporated to help give long service life. Packings are available with and without

surface graphite. Get more information about R/M High-Temperature Valve Stem Packings now.

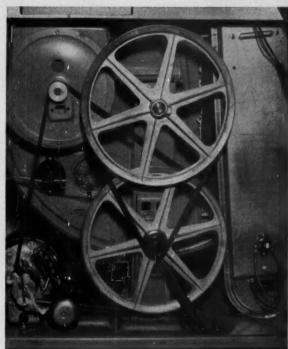
PACKINGS



For complete information on R/M High-Temperature Valve Stem Packings, write for catalog. Packing Division, Raybestos-Manhattan, Inc., Passaic, N.J.



sintered metal, and engineered plastic products



CX MOLDED V-BELT

Outlasts Other Belts 8-1
The Only Belt of its Kind . . .
Fully Molded, Completely Jacketed
Notched V-Belt

Ideal for small sheave diameters, short centers, high speeds

Micro-positioned strength member is supported in a "Power Arch" and locked into a homogeneous molded unit for perfect balance, cool, quiet, vibrationless operation. Locked-in length stability. Fully covered; prevents flex-cracking; maintains shape. Completely protected from atmospheric conditions; no ply separation; less wear on grooves. Let R/M rubber specialists work with you on V-belts, transmission or conveyor belting, rubber hose, molded or extruded parts.



Write today for free booklet shown: full details on a wide variety of industrial rubber products. Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N.J.

BOND FAILURES CAN BE PREVENTED! Here's how to stop 13 of them . . .

Type of Failure	Solution		
THERMOSETTING ADHESIVES			
Cohesive failure	Check film with solvent used in adhesive. It solvent softens the adhesive film or becomes tacky, this indicates insufficient cure. Make sure bond line time and temperature is used		
Adhesive failure from metal	If metal surface has a white, clean appearance, check cleaning technique.		
Adhesive failure from substrate other than metal	Try prime coat of diluted adhesive, also check compatibility.		
Cellular areas in adhesive line	Increase pressure and/or adhesive.		
CONTACT ADHESIVES —room temperature setting			
Tacky film	If film should dry hard but remains tacky, the cause may be entrapped solvent or migration of plasticizer from one substrate.		
• Shiny areas	Poor contact, insufficient pressure or in sufficient amount of cement.		
• No bond	If heat reactivated type, adhesive was too cool at time of assembly or poor compati bility.		
Failure in adhesive from metal	Improper cleaning.		
From substrate other than metal	Incompatible or unclean surfaces.		
HOT MELT			
No bond	Incompatibility, adhesive too cool at time of assembly. Parts too cool at time of application of adhesive.		
EPOXY BASE ADHESIYES AND CASTING COMPOUNDS			
High exotherm	Mix lower volume and pour mixed materia into shallow tray, Cool base and activato before mixing or use Metermixing equipment		
Tacky film or casting	Improper base activator ratio, improper mix ing of base and activator, improper cure Check bond line temperature.		
Flexible casting or film of rigid adhesive or casting compound	Improper mixing of base and activator improper base and activator, improper cure Check bond line temperature.		

Bond failures can be prevented! Raybestos-Manhattan's adhesive experts also have solutions to less common causes of bond failures . . . based on more than 20 years' experience in the production of bonded assemblies and the manufacture of adhesives, coatings and sealers. Why not call on them today for the answers to your adhesive problems—no cost or obligation, naturally.





R/M Bulletin No. 700—It's packed with helpful technical information on Ray-BOND adhesives. Write for your free copy now. Adhesives Dept., Raybestos-Manhattan, Inc., Bridgeport, Conn.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Paramount, Calif. • No. Charleston, S.C. Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada



bend, stamp, cut, and form away! this handsome pre-finish stays put

VINYL-ON-METAL is cooperative. Stamp it out. Punch it out. Even weld it! Form it the same ways you form unfinished sheets. The unique colors, textures and patterns of Vinyl-on-Metal sheeting or coils remain unaffected. The tough resilient surface stays - won't chip or peel in use. It protects against tearing or wrinkling-minimizes surface damage during fabrication and assembly. Vinyl-on-Metal. is already widely and successfully used for furniture appliances, transportation interiors, building construction, and in many other fields. For a highly informative booklet, "Vinyl-on-Metal," write to Monsanto Chemical Company, Plastics Division, Room 753, Springfield 2, Mass.

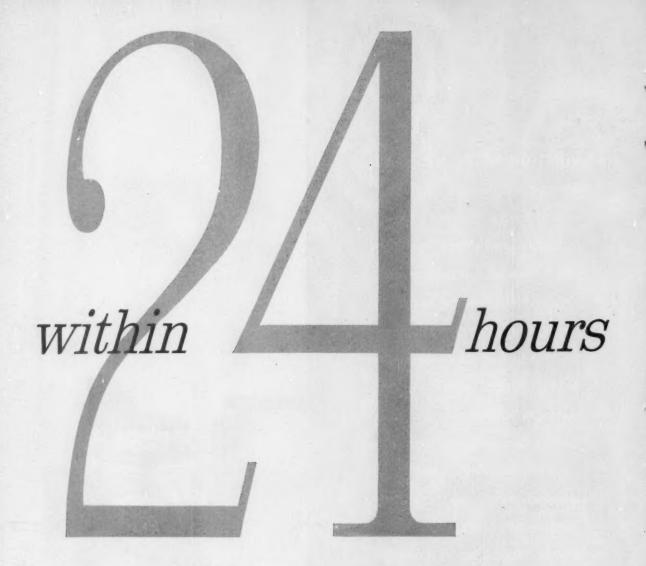


Monsanto developed and today supplies Opalon® and Ultron® vinyls for superior finishes on steel, aluminum, and other metals, and on wood, paper and glass.

MONSANTO DEVELOPER IN PLASTICS



Circle 427 on Page 19



any day is the right day

to order your Timken® 52100 steel tubing, and within 24 hours of receiving your order it will be on its way. To give you this fast service on less than mill quantities, we stock 101 sizes—from 1" O.D. to 10½" O.D.—in a new, modern warehouse. And the same fast service is available on 50 sizes of 4620 tubing. You can save time and money by remembering that 90% of all your structural

parts can be made from one or the other of these two steel analyses. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN®
Fine STEEL

(What's wrong with this picture?)



Are your bookkeepers better equipped than your engineer-draftsmen?

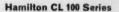
Yes, today's bookkeeping procedures demand accuracy and productivity—equipment that guards against error, while saving time. Your professional engineer-draftsmen, too, need modern equipment for top efficiency, as their work helps establish your productivity throughout the entire product-planning and manufacturing cycle.

Your draftsmen, your productivity, deserve new <u>Hamilton</u> space-and-time-saving equipment—from <u>Bruning</u>

You keep your best men productive by giving them the equipment they need to do their best work, and you eliminate costly errors fostered by inadequate or antiquated equipment. In Hamilton equipment, you get top productivity for every square foot of floor space.

Not only do all Hamilton units start to pay you the minute they go on the job, but they keep working harder for you every minute—because they're so ruggedly constructed, designed for greater ease and comfort—consequently lower fatigue.

The Hamilton units are themselves a product of meticulous engineering and long experience—features and dimensions established as *ideal*, in many thousands of industrial installations. Yet they deliver the flexibility that every individual and every department require. Our experienced planning engineers are at your service to help select the best arrangements for your needs.



Entirely new, canted-leg styling assures stability without side crossrails. Strata-Core board, with green linoleum surface, both sides steel edged; tilts 0° to 40°. Fully adjustable recessed footrest; steel reference, tool, and catalog drawers. Other fine features, superb styling in light Sahara-Tan, satin-chrome hardware.





Hamilton De Luxe Auto-Shift Tables
Scientifically seasoned drawing surface; concealed mechanism controlling height and slope flexibility, can be moved with fingertip pressure; linoleum-covered reference surface. Many functional features, combined with prestige styling. Front table, basic table, and rear reference desk—matched styling.

Hamilton L-Contour Unit Counterbalanced, range of board adjustments permits frequent position changes—at finger touch—offering greater flexibility of work arrangement, lessening fatigue. Telescoping legs adjust height 30° to 31°. Generous storage facilities, durable linoleum reference surface. Beautiful utilitarian styling, maximum space efficiency, constructed for long service.



Put draftsmen in a "position" to do better, faster work!

Bruning's all-new Neoglide drafters literally help draftsmen straighten up and do faster, better work.* They provide complete maneuverability on any board at any angle without adjustment! Reinforced U-beam construction assures rigidity, strength, and accuracy. Resistance-free movement of vertical beam and hidden counterweight provide fast "floating" action. Touch-control protractor head gives automatic, pinpoint angle selection.

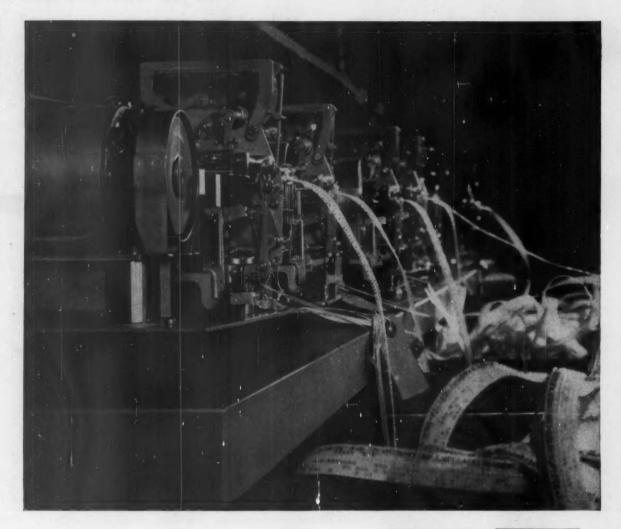
*Study of 300 draftsmen showed 35% savings in drawing time—1/5 the backaches—on vertical or near vertical boards.



BRUNING

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Circle 429 on Page 19



Continuous operation— a Teletype equipment tradition

All Teletype equipment . . . like the tape punches being final-tested above . . . are subjected to a rigorous quality-control program to insure that the units will give continuous, day-in, day-out performance in your service. Such performance is a Teletype tradition, established during more than fifty years of manufacturing data communications equipment.

To maintain this performance tradition requires much more than testing, however rigorous. It begins with the very design of the units themselves—the product of extensive research and development facilities, backed by cumulative experience. And it involves precision manufacture—employing the latest technological advances, from highly specialized machine tools and automated processes to electronic measuring and sensing devices.

When you select Teletype equipment to speed your communications and cut your paperwork costs, you can be sure of built-in quality. Teletype Corporation manufactures this equipment for the Bell System and others who require the utmost reliability from their data communications systems.



Typing Tape Punch



Tone Bende



Send-Receive Page Printer



Automatic Send-Receive Set

FREE Model 28 line tolder. Write Dept. 28K. 5555 Touhy Avenue, Skokie, Illinois.

TELETYPE

CORPORATION
SUBSIDIARY OF Western Electric Company INC.



Downtime problems solved by non-lubricated bearings of TEFLON°

Costly shutdowns for lubrication were required in the dryer section of a papermaking machine . . . until the journal bearings were replaced by bearings using a filled composition of a Du Pont Teelon TFE-fluorocarbon resin. The exceptionally low coefficient of friction offered by Teelon resins now makes lubrication unnecessary. In addition, the new bearings eliminate problems of oil leakage, splatter and contamination of paper which had previously occurred.

These bearings of a filled TEFLON resin, reinforced by a rigid backing material, operate smoothly up to 1,000 psi and 150 surface feet per minute.

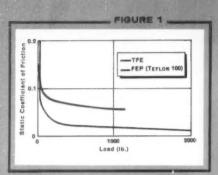
If your equipment involves problems of bearing life, performance or lubrication, consider the time and money saving advantages offered by bearings of Teflon. Filled compositions and reinforced constructions of Teflon are available to meet the requirements of increased load and speed or high wear resistance—and Teflon fluorocarbon resins provide dry lubrication.

On the following page you will find basic data on the properties and performance of bearings of TEFLON and the ways they make possible cost-saving design improvements.

TEFLON is Du Poni's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resin.



Bearings of TEFLON: major design considerations



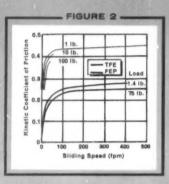


TABLE 1.

	TRUCTIONS	HOUS
Material	Lead (pei) 2 ft. per minute velocity	Velocity (ft./min.) 100 psi load
Unmodified TFE resins	500	25
Compounded TFE resins	2,500	200
Reinforced TFE resins	40,000	1,000
Fabric of oriented fibers of a TFE resin	60,000	60

Construction	Wear	Conditions
Molded TFE resin	s	
unfilled 25% graphite 22% glass 25% copper	200 mg./hr. 0.7 mg./hr. 0.2 mg./hr. 1.2 mg./hr.	410 stainless steel shaft 1" long x ¾" I.D. 60 ft./min. 42 lbs.
25% graphite 22% glass	0.7 mg./hr. 0.4 mg./hr.	410 stainless steel shaft 1" long x ¾" I.D. 215 ft./min. 21 lbs.
unfilled 15-25 graphite 15-25 glass 4-8 copper	0.74 mg./hr. 0.0015 mg./hr. 0.0015 mg./hr. 0.032 mg./hr.	303 stainless steel shaft ½" long x ¼" 1.D. 9.8 ft./min. 35 psi White, H.S. National Bureau of Standards
Fabrics of oriented fibers of TFE resins	6 x 10 ⁻⁴ in/hr.	1" shaft 25 ft./min. 1150 psi
Reinforced TFE resins	4 x 10-7 in/hr.	1" shaft 100 rpm 2000 psi

Properties of bearings of TEFLON

TEFLON fluorocarbon resins have properties which make them excellent materials for journal and plane-surface bearings. Filled compositions and reinforced constructions are usually used to tailor bearings of TEFLON for increased loads and velocities or high wear resistance. Among the major benefits that TEFLON resins offer as bearing materials are:

- 1. Low coefficient of friction—The static coefficient of friction of Teflon resins is even lower than the dynamic value. At high loads and low velocities, Teflon resins have a lower friction than any other solid material . . . significantly lower than lubricated metal bearings. (See Figure 1 for static coefficients of both Teflon TFE resins and the new, melt-processible Teflon FEP resin. The kinetic coefficients of friction vs. sliding speed at 73°F, are shown in Figure 2.)
- 2. Temperature resistance—Bearings of TEFLON TFE resins have exceptional thermal stability and are suitable for continuous service up to 500°F. At -450°F. these resins show the same friction that would be expected for similar conditions of load and velocity at room temperature.
- 3. Chemical resistance—Bearings of Teflon resins are completely resistant to virtually all chemicals and solvents, They do not absorb moisture and are completely unaffected by outdoor exposure to weather.
- **4.** Other properties Bearings of TEFLON resins are tough, abrasion re-

sistant, and have the ability to embed hard foreign contaminates.

WHERE TO USE

Bearings made of TEFLON resins are being used where lubricated bearings are undesirable or incapable of operation, in extreme temperatures or corrosive conditions, or where there is a possibility of lubricant failure. They are used where safety and reliability are essential. They are used near substances that must not be contaminated; with non-lubricating liquids such as gasoline; with corrosive substances; at low or high temperatures where common lubricants are useless; under extreme conditions of humidity; in areas where there is danger of fretting or galling; where stick-slip motion is undesirable; where space or weight savings are essential.

SPECIAL CONSIDERATIONS Load and Speed

Unfilled TEFLON resins are used in light load, low PV factor bearings. For higher loads and speeds, reinforced constructions and filled compositions of TEFLON provide the increased compressive strength, thermal and dimensional stability, heat dissipation and wear resistance required. See Table 1 for indications of the capabilities of various types of bearings of TEFLON TFE resins.

Bearing Life and Wear

Bearing life is usually dependent on wear, which in turn is dependent on load, surface sliding speed, lubrication and shaft finish, as well as clearances and construction. Hence, it is not practicable to define wear rate for all conditions. Table 2, however, is indicative of the wear rates for some typical bearing applications.

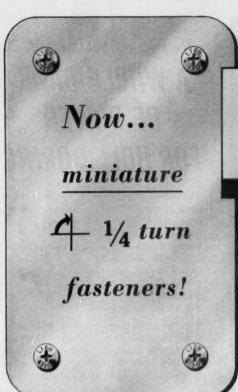
FOR MORE INFORMATION about the properties and uses of bearings of TEFLON and the new fact-filled booklet "Designing with TEFLON", write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, T-25-10, Room 2526, Nemours Building, Wilmington 98, Delaware.

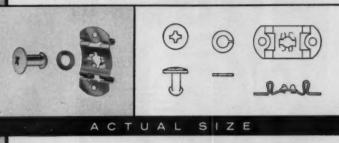
In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.



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LION

FASTENERS

14 TURN OPEN . 14 TURN CLOSED

LIGHTWEIGHT • STRONG MINIMUM ENVELOPE

A new size has been added to the Lion family of quick-opening fasteners...a miniature size. Small, compact, yet strong and rugged, these miniatures aid in reducing overall dimensions and weight without sacrificing the important advantages of larger Lion Fasteners.

ALIGNMENT NOT CRITICAL

Stud "floats" to accommodate misalignment. The hole in the sheet for the stud has an area 60% greater than the stud diameter. This allows a .030 float in all directions.

WIDE VARIATION IN STACK HEIGHT

Six different studs accommodate total material thicknesses (both sheets) of .040 minimum to .159 maximum.

Total sheet thickness served by any

one stud may vary as much as .019 without affecting operation. A Lion Miniature Stud, specified for a thickness of .0863, for example, will accommodate total sheet thicknesses from .080 to .099.

SWAGED-NOSE STUD

Extra strength and smooth operation are made possible by the exclusive Lion swaged nose design. All the metal is put to work. There are no holes, thin cross pins, or milled slots to weaken the cross-section. Case hardening assures long, trouble-free service without wear.

LARGER SIZES AVAILABLE

Lion Fasteners are also available in two larger sizes—No. 5 (mil spec) and No. 2—to meet the needs of aircraft, missile and ground support equipment. The heads are supplied in a wide variety of styles including oval, flush, wing, ring, notched and knurled.



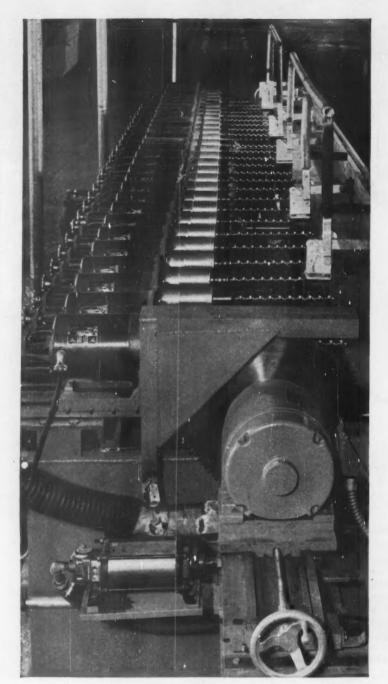
FASTENER HANDBOOK

Send for your free copy of Southco Fastener Handbook No. 9. Gives complete engineering data on Lion Fasteners and many other special fasteners.

Write to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pennsylvania.

e1959





These Wagner Motors Provide ...

A WHOLE BANK OF POWER FOR HOLE BORING

Those are Wagner polyphase motors lined up behind the bits. Thirty of them, each rated at one horsepower. They provide the muscle needed to drill thirty holes through six 2 x 4's, simultaneously and in six seconds flat. The saw on the end of the rig—powered by a five horsepower Wagner "Doubly Protected" polyphase motor—cuts the boards to size at the same time.

This wood boring machine, manufactured by the Indiana Foundry Machine and Supply Company, is installed in the new Kopper's Company, Inc. Plastics Division plant in Detroit, Michigan.

It's not too often that you see thirty motors lined up like this, providing power for one machine. But, whether the number of motors in a particular application adds up to 3, 30, or 300... if they're Wagner Motors, you know they're really doing a job. That's usual, for Wagner Motors have been getting the job done for more than 65 years. And, a program of constant research and development in electric motor design makes sure that Wagner Motors will continue to lead where it counts... in performance!

Mind a suggestion? Call your nearby Wagner Sales Engineer for an analysis of your next motor application, be it for plant or product. Whatever your requirements, Wagner can supply a standard motor, or build a special motor to fit your needs. There are Wagner branches in 32 principal cities across the country, at your service.

Wagner builds Polyphase Motors in ratings from 1/6 through 1,000 hp.; single phase, 15 hp. and smaller.



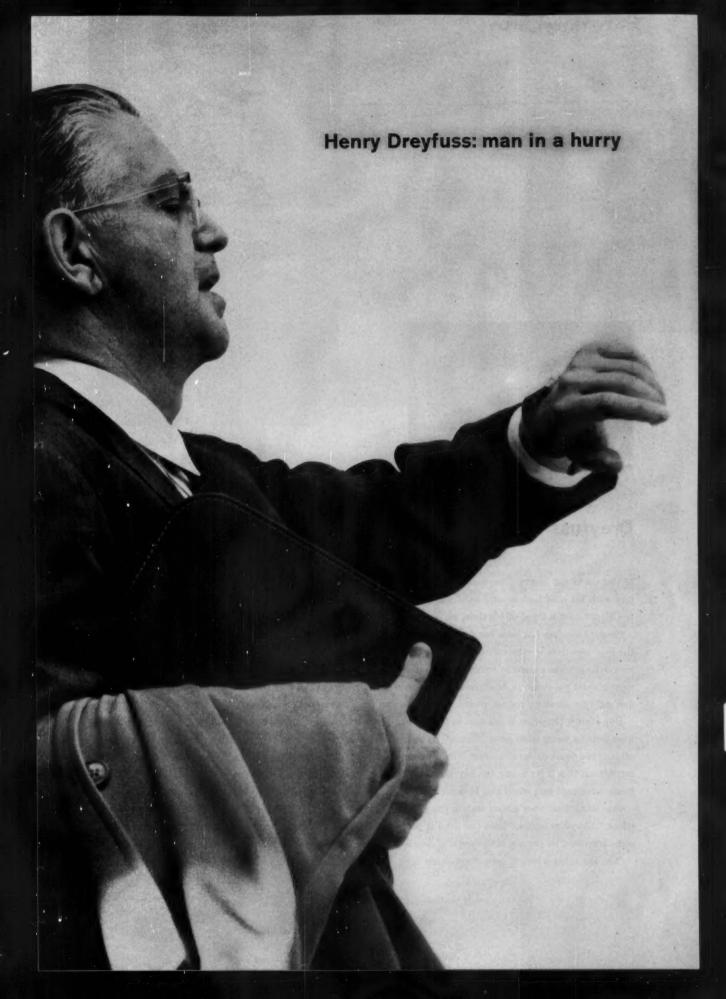
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SERVING 2 GREAT GROWTH INDUSTRIES - ELECTRICAL • AUTOMOTIVE
Circle 433 on Page 19









Dreyfuss talks design

If you could get Henry Dreyfuss to sit still long enough for a caricature, the drawing would inevitably show him with his coat half on and briefcase in hand. Most likely, he would be on his way to the airport. He's on the East Coast a third of his time, on the West Coast a third, and the other third in between.

Henry Dreyfuss has been busy ever since he gave up scenery design in the late Twenties and helped pioneer the business that is now called industrial design. In the early days, he gave a new look to everything from hinges to pianos, cigarette lighters to tractors. Today he can look back on a career of redesigning vacuum cleaners and gas stations, bowling alleys and ship interiors, typewriters and dental equipment, magazine formats and military strategy rooms, plumbing fixtures and the Nike missile launcher.

But Henry Dreyfuss is not one to look back. There are designs on his boards today that will influence our lives twenty years from now. "Time," he says, "is one of the designer's big problems. A design assignment is often three years in development. The item may not be on the market for another three to ten years. After it's introduced it will be in use for any number of years. In order to design that far ahead, our ideas have to be fresh, advanced and sprightly. It is a challenge to have to think as far ahead as we do."

One thing that goes a long way is the Henry Dreyfuss design credo, and it is all about people. "It says in effect," Dreyfuss states, "that the item is going to be ridden in, sat on, looked at, talked into, operated or in some way used by people. If the point of contact between the product and people causes friction, we have failed.

"On the other hand, if people are made safer, more comfortable, more eager to purchase, more efficient, or







just plain happier—we have succeeded." And succeed Dreyfuss does, by following this yardstick for effective industrial design: 1. Safety and convenience of use. 2. Ease of maintenance. 3. Cost, including tooling, production and distribution. 4. Sales appeal. 5. Appearance.

Selection of the right material for the job plays an important role in satisfying each of the five requirements. As a matter of ethics and sheer common sense, Henry Dreyfuss, like any member of the American Society of Industrial Designers, will not endorse any one material. "We have worked with all materials. What we want is the material that is right for the job. We look for the material that combines reasonable cost with the ability to be fabricated economically, and at the same time will give the product the built-in quality and durability it needs to sell well." With no-nonsense requirements like that, it is not surprising that a great many Dreyfuse-designed products use steel in one way or another.

Steel has strength, integrity and honesty. Steel is what the designer is apt to call a 'natural.' Dreyfuss feels that the public's image of steel depends largely on the product itself. A massive steel vault door conjures up an image of strength, imperviousness. Stainless Steel tableware suggests style and modernity. Steel curtain wall panels give buildings the look of tomorrow.

The moral is this: steel has been with us for ages, yet it is the modern metal, the metal of the future. Its enduring modernity will continue to be recognized, and used, by designers like Henry Dreyfuss.

(turn the page for a new look at steel)



United States Steel

designing with (USS) High Strength Steels

Good design goes beyond material selection. Once the choice has been made, the designer's job is to take full advantage of the material's properties. Few materials offer designers as much opportunity as high strength steels.

USS COR-TEN Steel is a name that has become a byword in design circles. It is a time-tested, high strength low-alloy steel. Structural designers welcomed COR-TEN Steel because it allowed them to pare dead weight and to lower maintenance costs. As structures, mobile equipment and machinery got bigger and bigger, dead weight became more of a problem. Even when weight could be shaved without stress problems, durability suffered. This high strength steel answered both problems.

Strength did it. Cor-Ten brand and other USS High Strength Steels have a 50% higher yield point than structural carbon steel. They permit as much as 33% weight reduction. They have superior resistance to atmospheric corrosion and abrasion, so there is little reason to overdesign. Their fatigue and impact properties are excellent. Here is a quick look at three well-known USS High Strength Steels:

USS Cor-Ten Steel has a yield point 50% greater than structural carbon steel, has four to six times its resistance to atmospheric corrosion. It is used to do any one of these three things: 1) in slimmer sections to cut weight at no strength loss; 2) in equal sections to increase load-carrying capacity, cut maintenance and lengthen life; and 3) any number of combinations of 1 and 2. Cor-Ten Steel also has greatly superior paint adherence and is used where a longer interval between repainting is wanted.

USS Tri-Ten Steel, with its 50% higher yield point than structural carbon steel, has superior notch toughness at low temperatures and keeps rugged equipment operating even in sub-zero weather. Its high endurance limit makes Tri-Ten Steel ideal for mobile equipment that must take repeated loading and reversals of stress. It is a natural for welded structures and bridges.

USS Man-Ten Steel also has a 50% higher yield point than structural carbon steel, and is the low-cost member of the family. Weight reduction as little as 17% with Man-Ten Steel will save money on material cost alone. Man-Ten Steel is a tough, durable steel and widely used in earthmoving equipment, truck frames, material handling apparatus and riveted bridges.

High strength steels represent but a few of the over 3000 grades of steel in existence today. United States Steel makes a complete line of high strength steels, as well as constructional alloy, stainless and carbon steels. Bring your design problems to us. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, COR-TEN, MAN-TEN and TRI-TEN are registered trademarks.

COR-TEN Steel was developed by U.S. Steel and first used in 1933.

Dead weight in stationary structures is costly; in mobile equipment dead weight requires more power to move.

USS High Strength Steels' yield points are all 50,000 psi min. compared to 33,000 psi for structural carbon steel.

Send for the manual described at the right for a comprehensive guide on how to design with high strength steels.

MAN-TEN Steel costs only about 20% more than structural carbon steel; TRI-TEN Steel about 36% more, and COR-TEN Steel 42% more.





Cranes have to operate in allweather temperatures and are subject to stress and shock. That's why many of them are made of tough TRI-TEN Steel.



Light standards stay good looking for years because of COR-TEN Steel's outstanding atmospheric corrosion resistance. Paint life is extended. Silm design is made possible by COR-TEN Steel's strength.



TRI-TEN Steel has cut weight and cost of dozens of major bridges. In the bridge shown here, TRI-TEN Steel saved a quarter of a million dollars.



One of the first applications of COR-TEN Steel was in hopper cars for weight reduction and longer life. Today, use of COR-TEN Steel can save hundreds of dollars over the life of a car.



MAN-TEN Steel, used in truck frames and body members, reduces dead weight and increases payload.



The LPG cylinder business uses considerable amounts of MAN-TEN Steel because of its strength, cost and ease of fabrication to lighten the weight.



This mark tells you a product is made of modern, dependable Steel.

Here's a book that is in the hands of thousands of engineers and designers. It is your guide to the design of lighter, stronger equipment and structures.

design manual for high strength steels

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Engineering Considerations
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Flat Plates in Edge Compression
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Shear

City.

Rivets Flat Plates in Shear

Stresses in Beams

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Characteristics of USS High Strength Steels
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United States Steel
Room 6149
525 William Penn Place
Pittsburgh 30, Pa.

Please send me "Design Manual for High Strength Steels"

Name

Title

Company

Address

_State

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

MICROSIZE FLEXLOC LOCKNUTS SAVE WEIGHT AND SPACE IN SMALL ASSEMBLIES



Because they require no auxiliary locking devices, precision microsize FLEXLOCS (Shown actual size—over 4000 of them) simplify design, save weight and space, help eliminate costly specials. Positive action of locking collar assures a high degree of mechanical reliability.

INDUSTRIAL FASTENER Division

JENKINTOWN 18, PENNSYLVANIA

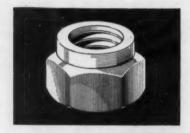


Require no separate locking devices . . . simplify design and installation

Where design calls for miniature threaded joints able to withstand vibration, microsize FLEXLOC locknuts offer you the optimum in simplicity, mechanical reliability, and strength-to-weight ratio. Featuring one-piece, all-metal construction, they require no auxiliary locking devices. No wiring, jam nuts or cotter pins...nothing extra to put together, come apart or get lost . . . no superfluous weight or bulk. They facilitate design, save assembly time, simplify inventory, help cut fastening costs all around.

You can rely on these tiny, precision fasteners to lock and stay locked wherever wrenching stops (use them as locknuts or stop nuts). They will not shake loose. And their locking power is not affected by moisture, dryness, oil or grease... nor by repeated removal and reuse.

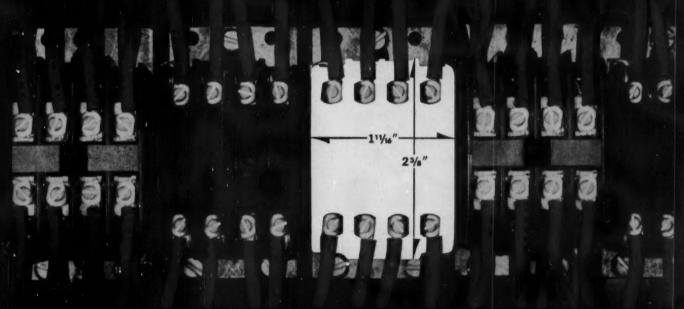
Your authorized distributor stocks microsize FLEXLOC locknuts (and microsize FLEXLOC self-locking clinch nuts) in standard sizes #0-4 in a variety of materials and finishes. See him or write SPS. Request Bulletin 2249.



SIZE	Across Flats MAX. MIN.	Hex. Height	Across Corners	Height	
		MIN.	REF.	MIN.	REF.
0-80 NF-38	.111	.107	.046	.121	.075
1-64 NC-3B	.127	.123	.056	.140	.090
1-72 NF-3B	.127	.123	.056	.140	.090
2-56 NC-3B	.158	.153	.067	.176	.105
2-64 NF-3B	.158	.153	.067	.176	.105
3-48 NC-38	.190	.183	.071	.210	.120
3-56 NF-3B	.190	.183	.071	.210	.120
4-40 NC-3B	.190	.183	.071	.210	.120
4-48 NF-3B	.190	.183	.071	.210	.120

new machine tool relay cuts panel space

9999



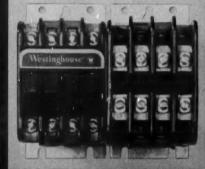
Actual size photo of machine tool panel



new machine tool relay cuts panel space 50%, reduces installed cost over 20%

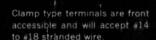


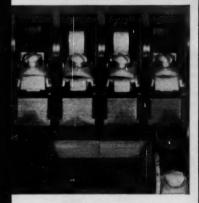
Machine tool relay is rated 6 amps, 300 volts a c, from 2 to 8 polesin 2 basic frames. Relays can be butted against each other to save space.



Here's the new Westinghouse relay that cuts the control panel space requirements as much as 50%. Specifically designed for use on automated machine tools, this relay is smaller than any other similar unit available. Relays can be butted against each other in banks. What's more, both 4 and 8 pole frames have the same mounting dimensions, occupy the same panel area, and can be mounted adjacent to each other without additional electrical clearances. Wiring a panel is easier, too. Relay terminals are all readily front accessible. Each of these clamp type connections has a wire stop . . . installation is faster and costs less. You actually save more than 20% over outdated relays. This new relay has load rating of 6 amps, 300 volts a-c—found by experience to be ideal for most of the machine tools now being designed. Want more information? Contact your nearest Westinghouse representative or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa. Remember: You can be sure if it's Westinghouse.

The Westinghouse BF relay is available from stock, now.





Circle 435 on Page 19

J-30318-1-3



Westinghouse

NEW MIGILL CAGEROL

deliver up to 10 times the life of ordinary needle

You can confidently specify new CAGEROL cage type needle roller bearings to increase the expected life of your bearing applications, up to 10 times — as compared with end-guided needle bearings. This new McGill bearing will easily carry the usual needle roller bearing loads where shaft misalignment and speeds exceed the capabilities of ordinary needle bearings.

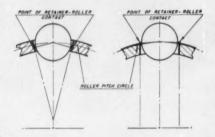
In this new McGill design a precision tubular cage spaces and locates specially heat treated crowned rollers. They are positively controlled to insure concentricity and prevent heat increases at higher speeds. The black oxide finish on retainers provides corrosion protection and stores lubricant in the porous surfaces. Friction is further reduced.

MR series CAGEROL bearings are interchangeable dimensionally with all heavy duty needle bearings. They are available with or without separable inner races.

Built especially for the tougher applications CAGEROL bearings feature many design and construction advantages. Put these new bearings and the McGill engineering department to work for you. Ask for recommendations.

ROLLERS CROWNED TO PREVENT "END LOADING"

Rollers are crowned to relieve ends and prevent "end loading." Under load, stress is distributed uniformly throughout the length of the roller raceway. This prevents metal fatigue and premature bearing failure. Flat roller ends fully engage integral race shoulders for maximum possible support. Specially heat treated high carbon-chrome SAE 52100 steel insures long roller life.

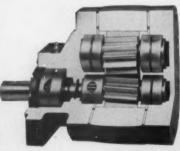


TAPERED RETAINER POCKETS GIVE BALANCED SUPPORT TO ROLLERS

Proper roller guidance is assured by tapered retainer pockets with retainer OD selected to fall outside the roller pitch circle. This establishes roller and crossbar contact on a concentric plane just below center. The McGill design insures balanced roller support and eliminates corner wear from edge loading of straight pocket walls where the retainer OD and pitch circle are coincident. The cage is supported by the outer race flanges.



CAGEROL bearings are being used by JOHNSON MOTORS in the upper journal positions of their 35 horsepower motors. Shown is the JOHNSON 35 h.p. SUPER SEA HORSE.



McGill CAGEROL bearings support the internal gears which rotate and operate under high pressure in COMMERCIAL SHEARING & STAMPING COMPANY oil hydraulic pumps and motors.



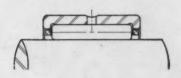
B & B INDUSTRIES selected CAGEROL Bearings to permit increased roll pressures and reduced maintenance in their first anti-friction Calender Stack bearing units for Pickers in the textile industry.



WRITE TODAY FOR FREE McGILL BEARING CATALOG
No. 52-A for complete data on McGILL GUIDEROL, CAMROL,
MULTIROL and CAGEROL BEARINGS.

BEARINGS





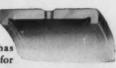
RETAINER BUILT FOR ACCURACY AND MINIMUM FRICTION

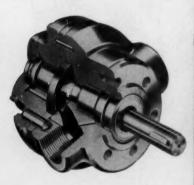
Simultaneously punched pockets in a continuous retainer assure the accuracy of race and roller alignment. The black ferrous oxide retainer finish absorbs and retains lubrication. The resulting low friction coefficient provides excellent performance at high speed.



INTEGRAL RACE FLANGES SUPPORT CAGE

The SAE 52100 steel outer race has optimum hardness and surface finish for best performance. It is of one-piece, double-flanged construction. Flanges are integral with the race and support the cage around its circumference.

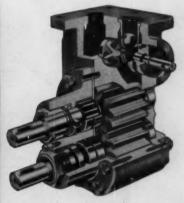




DOUBLE A PRODUCTS COMPANY has incorporated the advantages of the new CAGEROL bearing into their GEROTOR hydraulic pumps.



CAGEROL bearings have been selected for a variety of applications in HY-HOE back hoes manufactured by HYDRAULIC MACHINERY COMPANY.



Spur gear support requirements in ANTHONY COMPANY heavy duty hydraulic pumps are now being met by CAGEROL bearings.

engineered electrical products

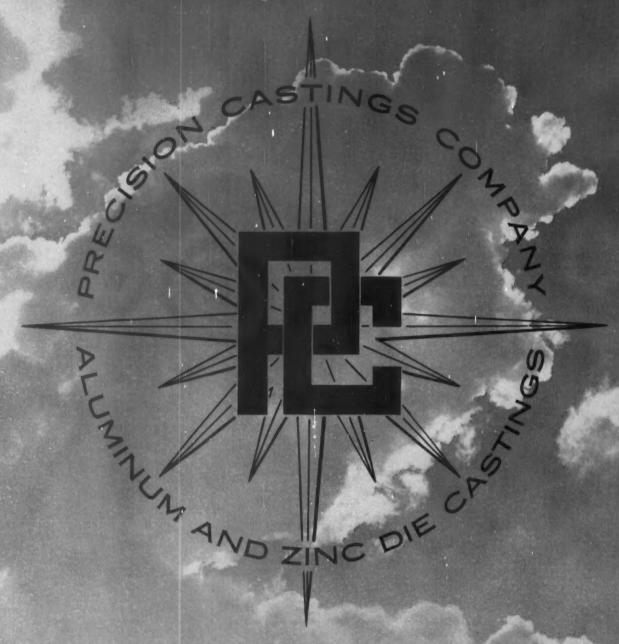


MULTIROL-GUIDEROL-CAMROL-CAGEROL

McGILL MANUFACTURING CO., INC., Bearing Division 200 North Lafayette Street, Valparaiso, Indiana

IF YOU BUY OR SPECIFY DIE CASTINGS ...

four points make



Modern business practice makes it necessary for your decisions to hinge on "the four points that make the great difference"—quality...capacity...service... and price. They challenge all serious competitors for your business.

We're facing this challenge squarely! — with plain talk and honest performance—to make Precision Castings Company your best source for die castings by providing what you want in the four areas that really count!

the great difference!



QUALITY

Precision die castings help insure the quality of your product. They're made with metals and alloys that won't fall apart under extra hard use. They fit where your engineers want them. And they're precision-finished to save you the cost and trouble of extra processing.



CAPACITY

Precision's capacity increases your own corporate strength. We're equipped for large-volume production, providing a single, responsible source that saves you the inconvenience of multiple orders to different shops, with plenty of men and machines to keep your job moving and finished when you want it.



SERVICE

Precision furnishes a combination of pre-sale and post-sale services that go a long way toward helping your production people plan and stay on schedule. Our field men are die casting engineers who offer qualified design help. Deliveries reach you when, where and how you want them. If you need help, our service engineers will get there fast, and solve the problem without delay.



PRICE

The most important part of our job is to see that you get what you pay for! Your jobs are quoted in full, produced, delivered and billed at the original figure—with no unscheduled extra costs.



PRECISION CASTINGS COMPANY

DIVISION OF PRECASCO CORPORATION

CLEVELAND, OHIO . FAYETTEVILLE, N. Y.



To design their new portable sewing machine case, Singer Manufacturing Company needed a tough, lightweight material. They chose a new Koppers high-impact plastic . . . DYLENE® 400 polystyrene.

The case is exceptionally strong and weighs only five pounds! It's as compact as a small piece of luggage; easy to carry, easy to store, and it's attractive.

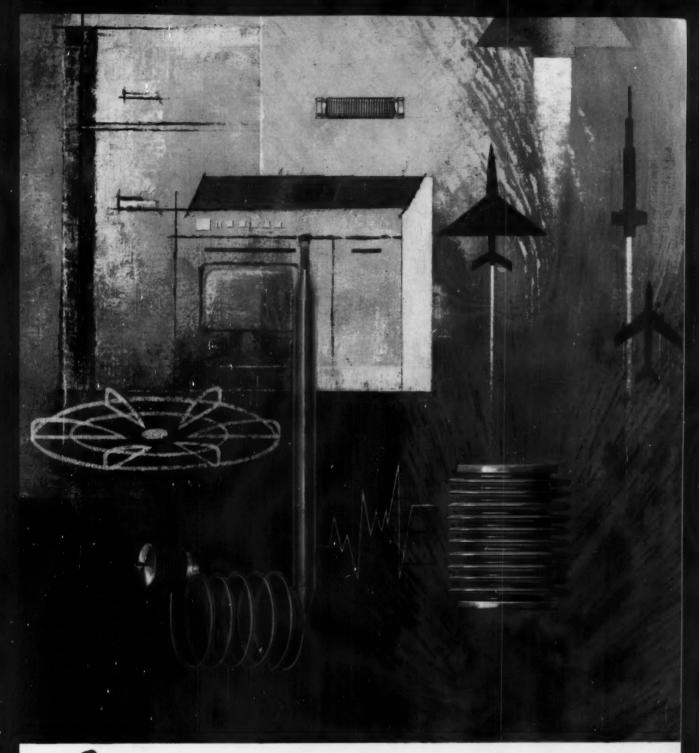
High-impact Dylene polystyrene is strong, durable; it molds cleanly without sharp edges, eliminating costly secondary operations. It has a high surface gloss and smooth finish. Dylene can take rough

handling, it won't chip or break. Dylene comes in a wide range of permanent colors.

Consider Dylene polystyrene for your next plastic product. For more information on Dylene and its various applications, write to Koppers Company, Inc., Plastics Division, Dept. MD10130, Pittsburgh 19, Pa. Koppers also makes these other fine plastics: Dylan® polyethylene, Super Dylan® high-density polyethylene, and Dylite® expandable polystyrene.

KOPPERS PLASTICS





Robertshaw products for the imaginative engineer—New and simplified ideas for harnessing temperature, pressure and movement are being sparked every day by products manufactured at Robertshaw's Bridgeport Thermostat Division. Only Bridgeport offers a choice of welded or hydraulically formed bellows and "packaged" bellows, plus other related control components.







PRESSURE RELIEF VALVES



FORMWELD BELLOWS ASSEMBLIES



FORMFLEX BELLOWS



MINIATURE FORMFLEX BELLOWS



DIASTAT ASSEMBLIES





Robertshaw sets the pace with

RELIABLE CONTROL COMPONENTS FOR ORIGINAL EQUIPMENT



... the most accurate and reliable ever produced!

Get the exact properties and characteristics you want in ultrasensitive Robertshaw FORMWELD Bellows, welded of any suitable alloy. They resist temperatures above 1000°F., pressures to 3000 pais plus, extreme vibration and corrosion conditions. Precision welding and control of plate tolerances assure closer control of bellows characteristics. FORMWELD Bellows provide more flexibility per thickness...lower hysteresis... greater load capacity without deformation...lower spring rates. Sizes ½2° O.D. to several inches O.D. Complete assemblies only.

Write for Bulletin 70.

Roboitshaw FORMFLEX* BELLOWS



. . . custom-engineered in many metals and sizes

Formflex seamless metallic bellows and "packaged" metallic bellows are hydraulically formed to meet your every need. Wide selection of bellows metals permits design freedom and exceptional performance under your exact conditions. Sizes available from ½" O.D. to several inches O.D. Bring your requirements for temperature and pressure sensing applications to Robertshaw's Bridgeport Thermostat Division for maximum results.

Write for Bulletin 10.

*Registration pending

Koloitskow MINIATURE FORMFLEX BELLOWS

. . . space and weight savers!

Formflex Bellows are now available in sizes as small as $\frac{1}{2}$ " O.D. These, plus other $\frac{1}{2}$ " and $\frac{1}{2}$ " O.D. units, permit further miniaturization in aircraft, missile, instrument and other equipment. Custom-engineered in many metals to give you the properties your application requires. Complete "packaged" bellows, when produced by Robertshaw, assure high reliability.

Write for Bulletin 10.

Robotshaw FLEXIBLE COUPLINGS



. . . solve backlash, misalignment problems!

Guard against misalignment friction, bearing wear, backlash and end-play with these small, rugged couplings. Absorb shock and vibration with minimum use of space and weight. Simplify your designs for servomechanisms, instruments and similar drive and control systems. Seamless metal bellows in wide choice of metals is connected to two hubs of various designs. Stock sizes accommodate shafts from 1/4" to 1/4". Other sizes custom-engineered.

Write for Data Sheet 80.

Robotham PRESSURE RELIEF VALVE

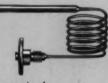
. . automatically reseals itself!

Vent dangerous pressure build-ups in transformers, air blast circuit breakers, tanks and vessels with the completely automatic Robertshaw Pressure Relief Valve. Minimizes maintenance and inspections. No breakaway seals to replace each time pressure is relieved. No resetting. Positive seal. Discharge occurs instantly when pressure reaches pre-set point. Valve closes instantly when pressure drops below pre-set point. Valve can be calibrated to open within $\pm 1\%$ of a given pressure. No moisture or contaminats can enter during blow-off. Rugged construction . . . corrosion-resistant. Sizes 6° and 10° standard . . , other sizes on request. Operating pressures possible to 30 psi.

Write for Data Sheet 90.

Robertskom

DIASTAT" ASSEMBLIES



. . . accurate, no-drift temperature sensing!

For all your short stroke temperature sensing jobs, Robertshaw Diastat Assemblies offer permanent accuracy with no drift... consistent calibration with no resetting... and extra-long life. Ideal for both large and small appliances, industrial and commercial dryers and similar heat and cold sensing applications. Typical stroke is .035" for a 1" diameter diaphragm. Sense temperatures as high as 650°F. No need for ambient temperature compensation in most applications. Stainless steel diaphragms for corrosion resistance. Custom-engineered and pre-assembled to save you money.

Write for Bulletin 60.



BRIDGEPORT

THERMOSTAT DIVISION
Robertshaw-Fulten Centrels Company
Milford, Conn.



N.S. Savannah, built by New York Shipbuilding Corporation, can sail for three

years on 138 pounds of nuclear fuel. A conventional ship would burn 80,000 tons of oil.

'round the world 13 times with fuel to spare ... the first nuclear-powered merchant ship

This is the Nuclear Ship Savannah, first of her kind. Capable of sailing over 350,000 nautical miles without re-fueling, she points the way to a new era in transport and travel at sea.

Her uranium oxide fuel is packaged in tubes of Nickel Stainless Steel...more than 5,000 of them. The fuel-element cans that hold these tubes are also made of this strong, corrosion-resisting metal.

Wherever you look, inside the reactor, almost everything is Nickel Stainless Steel. 200,000 pounds of it are used in the reactor area: for the lining of the reactor vessel, for the coolant pumps and tubing that circulate corrosive "hungry" water, and for the control rods inside the atomic pile.

At the design stage, engineers anticipated the high operating pressures—

1,750 pounds per square inch—and temperatures up to 508°F. They selected Nickel Stainless Steels to provide the strength and resistance to heat and corrosion needed to withstand these rigorous conditions.

So the next time you need more from a metal, remember the N.S. Savannah. Nickel Stainless Steel, or another Nickel alloy, may be the solution to your problem, too.

A note to Inco will bring you "First Steps Towards Solving Specific Corrosion Problems" and "High Temperature Worksheet"... simplified forms you can use to describe your metal problem. Perhaps our technical staff has information that will help you find the solution.

The International Nickel Company, Inc. 67 Wall Street New York 5, N.Y.



Inside the reactor nearly everything you see is Nickel Stainless Steel to withstand corrosion, high temperatures and presures that hit 1,750 psi. Reactor built by Babcock & Wilcox Co., Barberton, Ohio.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

GRAMIX COMPRESSOR BODY

GENERAL ELECTRIC AIR CONDITIONER

this GRAMIX part is a new concept in powder metallurgy techniques . . . engineered to meet requirements of GENERAL ELECTRIC'S new compressor design

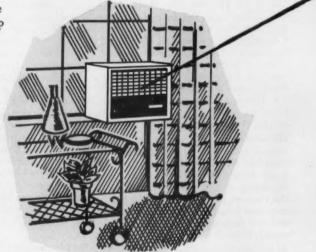
This large, complex shaped compressor body which is employed in air conditioners manufactured by General Electric is an outstanding example of a GRAMIX part engineered and produced to exacting specifications. As in all GRAMIX products of powder metallurgy, the alloy was created to meet exacting physical properties required in this particular application. Correct briquetting, controlled sintering procedures, precise finishing operations and rigid quality control throughout the manufacturing process assures General Electric uniform, dependable GRAMIX parts. The production of this body as a product of powder metallurgy has also enabled General Electric to effect important design changes in their air conditioning units.

GRAMIX engineers have the experience, the techniques and the equipment to produce top quality products of powder metallurgy. No matter what type of part you need, no matter what characteristics that part must possess, it will pay you to select GRAMIX . . . and get both "job-engineered" alloys and quality-controlled production to meet each specific operating requirement.



Write today for these helpful engineering manuals. No. 18 covers design and metallurgical

design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 covers GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy.





THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE - GRAMIX® POWDER METALLURGY - MEXICAN® GRAPHITE PRODUCTS - USG® BRUSI

IS VITAL PART IN



This part is shown 11/2 times size. Actual weight: 21/4 lbs.

X-271-2

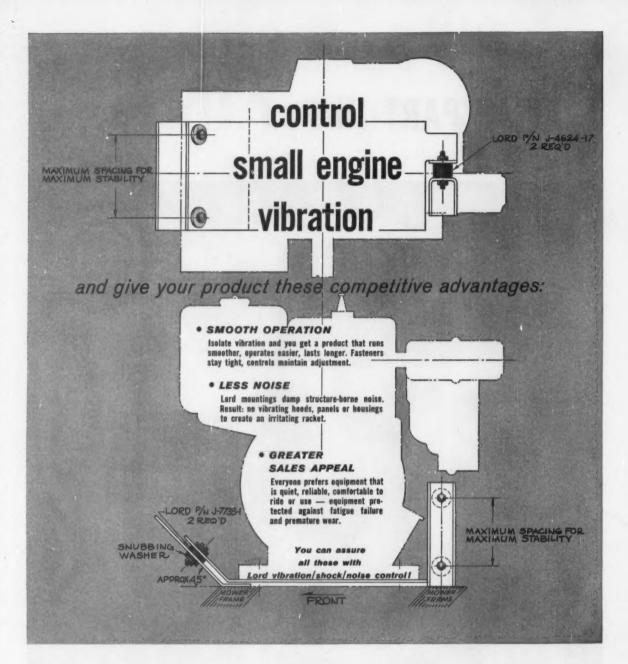
GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN

October 13, 1960

Circle 440 on Page 19

81



Wherever you use small engines—in mowers, scooters, golf carts, garden tractors, utility vehicles—you can give your product a real performance lift with a Lord flexible suspension.

How much improvement can you expect? One example: Think of the outstanding success in noise reduction achieved by the outboard motor manufacturers. Today, nearly all outboards include Lord suspensions.

Lord can design a mounting system engineered to your engine configuration and drive. High isolation efficiency and good stability can be achieved even in belt-driven systems. And the cost will prove attractive.

Why not use Lord's unmatched capabilities in vibration/shock/noise control to upgrade your competitive position. Contact the nearest Field Engineering Office or the Home Office, Erie, Pennsylvania.

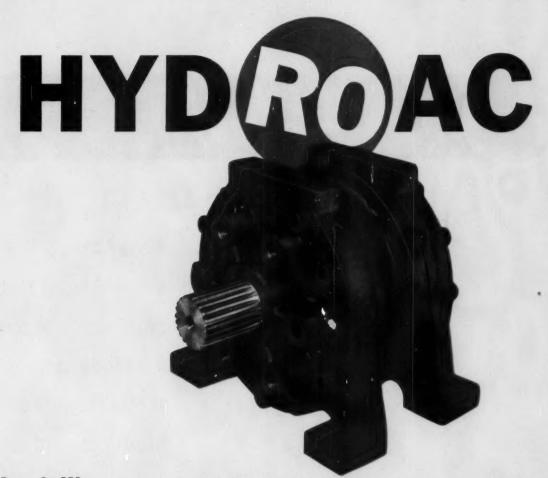


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LORD MANUFACTURING COMPANY . ERIE, PA.



Houdaille announces a new HYDRAULIC ROTARY ACTUATOR

for commercial applications

Houdaille, the world's foremost manufacturer of rotary type hydraulic equipment, now introduces a compact and powerful hydraulic rotary actuator for industrial use. Called HydRoAc, the Houdaille unit is designed to be used in a tremendous variety of applications ranging from turret lathes to farm machinery—from dump trucks to printing presses.

The superiority of Houdaille HydRoAc units is indicated by these specifications for standard units now available.

- Efficiency to 95% or over.
- Torque range from 1500 to 702,000 inch pounds @ 3000 p.s.i.
- Angular travel up to 280°.
- Operating pressure range from 250 to 3000 p.s.i.
- · Low starting (friction) torque.
- Can be foot, end or flange mounted.
- Highly responsive for servo system use.
- Bearings, splines and other requirements to suit your needs.

Special units and other configurations available on custom orders.

Send in this coupon for more information on Houdaille's HydRoAc

Please check potential use...

Turning Locking Indexing

Steering

Lifting Tilting

Driving Counter balancing

Bending Controlling
Clamping Valve operation
Adjusting Revolving

Lowering Opening Swinging Shifting Closing Metering Mixing Other Name

City

HOUSTILLE

... Specialists in rotary
type hydraulic equipment

Address

Zone

one State

Houdaille Industries, Inc.

Buffalo Hydraulics Division · Dept. B, 537 E. Delavan Ave., Buffalo 11, N. Y.



THE FIRST
NEW ALUMINUM
SCREW MACHINE
STOCK ALLOY
IN 25 YEARS

Alcoa Alloy 6262-T9*—
another Alcoa first—
promises to become
a standard in the
screw machine
products industry

*Patent applied for

a comparison of the characteristics of ALCOA SCREW MACHINE STOCK ALLOY 6262-T9 with other ALUMINUM SCREW MACHINE STOCK ALLOYS

	6061-T6	2017-T4 and 2024-T4	2011-T3
Strength	better	better(1)	better
Machinability	better	better(2)	not as good
Corrosion Resistance	same	better	better
Finishing Characteristics	same	better	better

(1) Based on Yield Strength

(2) Depends on Method of Machining

RELATIVE CHIP SIZE RATING

2011-T3: 1.0 6262-T9: 1.4 2017-T4 and 2024-T4:

2.0-3.0 6061-T6: 4.0

Visit the Alcoa exhibit, Booth 1410, National Metals Exposition, Philadelphia, Pa., October 17-21, 1960.

ALCOA'S NEW ALLOY 6262-T9 IS EXPECTED TO REPLACE ALLOY 6061 ENTIRELY AND 2017, 2024 IN MANY APPLICATIONS.

DESIGN ADVANTAGES—Higher typical properties (58,000 psi tensile strength, 55,000 psi yield strength, 10 per cent elongation) than 2011, 2017, 2024 and 6061—better corrosion resistance and finishing characteristics than 2011, 2017 and 2024—not subject to stress corrosion cracking.

ECONOMIC ADVANTAGES—Buyers can reduce inventories—stock one or two alloys instead of four—streamline purchasing—order in larger quantities.

PRODUCTION ADVANTAGES—Better machinability than 2017, 2024 and 6061.

For complete information, specifications, delivery of the newest aluminum screw machine stock alloy—Alcoa 6262-T9—call your nearest Alcoa sales office, or distributor, or write: Aluminum Company of America, 840-K Alcoa Building, Pittsburgh 19, Pa.



HIGHER STRENGTH—6262 offers higher strength than alloys 2011, 2017 and 2024.



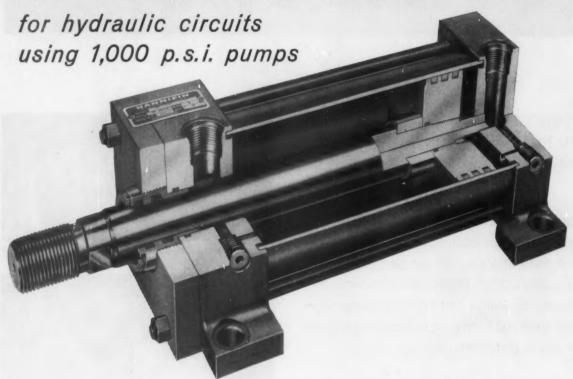
BETTER CORROSION RESISTANCE—6262 offers better corrosion resistance and finishing characteristics than alloys 2011, 2017 and 2024.



BETTER MACHINABILITY—6262 offers better machinability and higher strength than alloy 6061... corrosion resistance and finishing characteristics comparable to 6061.



NEW FROM HANNIFINTHE THOUSAND POUND LINE!



- A true hydraulic cylinder
 not a modified air cylinder
- Offered in nine bore sizes
 1" through 8"
- Every model withstands at least 1,000 p.s.i. in every bore size
- Built to save you money
 yet not "built to a price"

Now, for the first time in hydraulic cylinder manufacture, Hannifin offers a top quality cylinder tailored to the medium-high-pressure hydraulic circuits you operate off 1,000 p.s.i. pumps.

Series "L," the "Thousand Pound Line," is NOT a modified heavy duty air cylinder. It is built for the job... with steel heads and steel barrel for full compliance with J.I.C. hydraulic recommendations. Other extraquality features include an induction hardened and hard chrome plated rod, nodular iron piston with cast-iron piston rings — leakproof "Lipseals"," optional — longer cushions on cushioned models, and the Hannifin-developed bronze cartridge gland with both "Lipseals" and "Wiperseal" to keep the rod drip-free. S.A.E. straight thread "O" ring ports as recommended by J.I.C. are optional at no extra cost just as they are in the Hannifin heavy duty Series "H" hydraulic cylinder.

Parker-Hannifin field engineering service can help you meet your needs precisely, help you select the proper Hannifin cylinder for any service, air or hydraulic. Call your nearest Parker-Hannifin sales office or write direct for our new bulletin giving all dimensions of Hannifin Series "L" cylinders.



HANNIFIN COMPANY

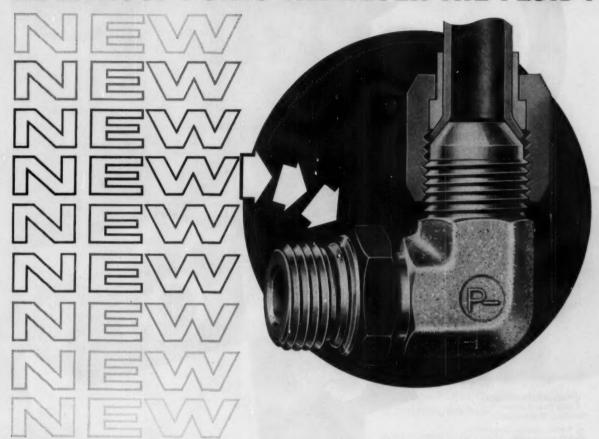
A DIVISION

515 South Wolf Road . Des Plaines, Illinois

EUMATIC AND HYDRAULIC SYSTEM COMPONENTS

3077-PE

PARKER PIONEERS AGAIN LEAKPROOF PORTS WHATEVER THE FLUID!



PARKER NOW OFFERS A METAL SEAL TO FIT THE S. A. E. STRAIGHT THREAD BOSS

Parker, whose straight thread fittings and straight thread ports have been accepted by S.A.E. (and now by J.I.C.) as industry standards for hydraulic devices, has now developed a **stainless steel** seal for use where the convential, synthetic rubber "O" ring is not acceptable.

Their new all-metal straight thread fitting features this resilient stainless seal, which seats within the confines of the S.A.E. straight thread boss configuration. The new seal cannot be removed from the fitting and, therefore, cannot be lost. It can be used again and again without damage to the boss or to itself. Because

it is 304 stainless, it works equally well with every known hydraulic fluid, petroleum-base or fire-resistant.

Parker offers steel and stainless steel straight-thread fittings with stainless seals in both their "Triple-loke": 37° flare design (illustrated) and their "Feruloke" flareless, "bite-type" design. Also available from Parker are tools with which to cut the mating S.A.E. boss.

Hydraulic designers who have hesitated to standardize on the leakproof S.A.E. straight thread boss on applications where they could not be sure what hydraulic fluid would be used are invited to write for complete engineering test data on this new development.

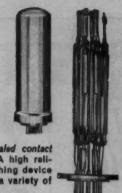


3199-PH

Puget Electro Products 5028 First Avenue Seattle 1, Washington 2 Bell Electronic Corporation 306 E. Alondra Gardena, California 2 Bell Electronic Corporation 1070 O'Brien Drive Menlo Park, California 3 Radio Specialties Co., Inc. 6323 Acoma Road, S. E. Albuquerque, New Mexico 4 Engineering Supply Company 6000 Denton Drive Dallas 35, Texas 5 Harrison Equipment Co., Inc. 1422 San Jacinto St. Houston 1, Texas 6 Busacker Electronic Equipment Co., Inc. 1216 West Clay St., Houston 19, Texas **7** Reiay Sales P. O. Box 186 West Chicago, Illinois 8 Srepco, Inc. 314 Leo Street, Dayton 4, Ohio 9 Pioneer Electronic Supply Company 2115 Prospect Avenue, Cleveland 15, Ohio 10 Relay Supply, Inc. 1492 Highland Avenue Needham 92, Massachusetts 11 Avnet Electronics Corporation 70 State Street Westbury, L. I., New York 12 Electronic Supply 1301 Hibiscus Boulevard P. O. Drawer 1655, Melbourne, Florida

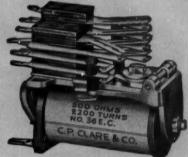


Type F relay-small, sealed, postage-stamp sized relay with unusual flexibility for long-life operation.



CLAREED sealed contact reed relay - A high reliability switching device available in a variety of packages.

for immediate delivery at factory prices



Type J relay—a compact telephone-type relay of unequalled long life and superior performance.



Mercury-wetted contact relay capable of billions of extremely fast operations with no maintenance.



Stepping switches-a full line with capacities from 10 to 52 points and capable of millions of steps without readjustment.

Here's what this new CLARE service means to you:

Top quality-the same fine design and long life you get in CLARE custom-built relays and switches

Fast service—overnight delivery on many items

Easy purchasing-because you can order CLARE devices along with other components

Able engineering assistance -available through CLARE field engineers, working in close cooperation with CLARE distributors.

When standard CLARE relays or switches meet your needs, distributor service saves you time, costs no more. When your special needs require custom design and production, CLARE custom-built devices give you exactly what you require.

C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., P.O. Box 134, Downsview, Ontario. Cable Address: CLARELAY

3 LAR

Related Control Components

BERYLCO INSPIRES NEW DESIGN THINKING



31/4 times actual size

Electrical connector of beryllium copper rod: By selecting a Berylco alloy, the designer met requirements for high conductivity, corrosion resistance, high contact force, and excellent resistance to creep. The connector also has enough yield strength to permit mis-alignment of the mating connector without loss of electrical contact. It is usable up to 300°F. Lead-in wires can be soft-soldered to the connector.

New advances in critical parts performance now possible The ever-widening and increasingly successful use of Berylco beryllium copper alloys is opening a whole new area of design thinking on parts. The list of attributes in this amazing alloy reads like a Who's Who of famous performance characteristics: good conductivity, high fatigue strength, non-magnetic, high strength, unusual wear resistance. resistance to anelastic behavior, good corrosion resistance, excellent hardness, wide operating temperature range. Find out what these characteristics can mean to the parts you are now working on. Write for our latest BERYLLIUM COPPER BULLETIN. To assist you further, an experienced, knowledgeable staff of field and mill technicians stand ready to translate design possibilities into performance realities.



Bearing race cast from beryllium copper ingot: The choice of Berylco alloy on this investment casting was easily made because its high fluidity provides good surface, close tolerances, excellent detail and the ability to cast thin sections. When added to the advantages of the alloy itself, like high strength and good wear resistance, it becomes easy to see why beryllium copper is being used more and more in several casting methods.



Bellows of beryllium copper strip: The design engineer on this part knows a Berylco alloy is a fine choice because its low modulus of elasticity (approx. 18.5x10°) gives greater deflection for a given pressure change than other high strength alloys. And it has good fatigue strength with a yield strength that gives excellent usable movement range.



THE BERYLLIUM CORPORATION

Reading, Pennsylvania

OHMITE RESISTORS

THE EXACT RESISTOR YOU NEED-WHEN YOU NEED IT -- FOR EVERY INDUSTRIAL AND MILITARY REQUIREMENT

Fixed . . . adjustable . . . tapped . . . noninductive . . . precision metal film and encapsulated wire-wound . . . thin type . . high-current-practically any resistor you need, you can find in the Ohmite line.

Ware Ohmite's huge stock of several million resistors in more than 2000 sizes and types contains a unit that fits your requirements. Many types are also available through Electronic Parts Distributors located across the Nation.

YOUR CUSTOMERS KNOW THE VALUE OF OHMITE QUALITY—
When a purchaser sees Ohmite resistors in a piece of equipment, he knows that equipment is designed and built for dependability.

HMITE ENGINEERING ASSISTANCE ASSURES THE RIGHT UNIT-O Selecting the right resistor for the job is sometimes a tough problem. Why not call on Ohmite application engineers to help out. Take advantage of their specialized skills and background.

> Write on Company Letterhead for Catalog and Engineering Manual 58

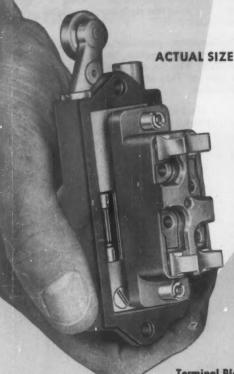


OHMITE Quality Components

OHMITE MANUFACTURING COMPANY 3618 Howard Street, Skokie, Illinois

RELAYS . R.F. CHOKES . TANTALUM CAPACITORS VARIABLE TRANSFORMERS . GERMANIUM DIODES

This New PLUGIVLIMIT

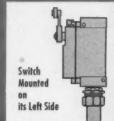


Terminal Block
Easily Wired
Without Removing from Box

CLASS 9007, TYPE AW

- Oil-tight construction
- Switch plugs in -in seconds
- Mounts without disassembly
- Wired without removing from box
- Reversible plug-in unit
 can be plugged-in
 with roller arm at either end
- Switch action can be reversed by simple screwdriver adjustment
- Present installations
 easily converted to plug-in
- Precision switch mechanism
 —only 5° to operate—
 25° overtravel in either direction
- Graduated markings around hub of roller arm simplify accurate settings
- Same price as standard Square D oil-tight limit switch

6 MOUNTING ARRANGEMENTS...WITH T DEVICE!



Switch Mounted on its Base with Conduit at Bottom



Switch Mounted on its Base with Conduit at Top



Switch Mounted on its Right Side



In any of the above arrangements, conduit can enter at either top or bottom by reversing box position



SQUARE D COMPANY

wherever electricity is distributed and controlled

SWITCH is SOEASY to Use!

SQUARE D LIMIT SWITCHES ARE Designed TO DO HUNDREDS OF JOBS - BETTER!

SMALL OIL-TIGHT LIMIT SWITCH -- CLASS 9007, TYPE AW



Surface mounting, roller arm operated



Surface mounting with angular adjustable roller arm



Surface mounting push rad operated with micrometer



Roller plunger operated with micrometer



Duplex switch, flush mounting, lever arm operated



Flush mounting

ROLLER ARMS AVAILABLE IN WIDE RANGE OF DESIGNS AND LENGTHS.



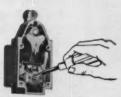
HEAVY-DUTY OIL-TIGHT LIMIT SWITCH -- CLASS 9007, TYPE T



Continuously adjustable lever arms, up to 80° overtravel



Transparent plastic cover available for instant inspection



even contact arrangements in one switch; only a screwdriver is required

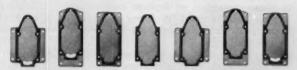


Rear shaft design for inaccessible



Many sizes and types of operating arms

WIDE VARIETY OF BASE PLATES
AND
MOUNTING HOLES...



Write for BULLETIN 9007 AW to Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin





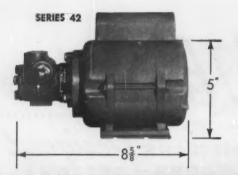


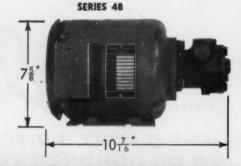












SAVE SPACE...WEIGHT...MONEY

with TUTHILL close-coupled pump and motor combinations

Tuthill close-coupled pumps and motor combinations are especially designed for applications where space is at a premium. Their compactness simplifies assembly operations and lowers production costs. Elimination of couplings, bases and adapters results in significant savings... and reduced weight means lower shipping costs.

Tuthill offers a complete selection of units with capacities up to 50 GPM for pressures to 500 PSI. A wide variety of special options is also available. Three standard units are pictured above.

Immediately available from stock

The series 42 units measure only $5^{\circ}x8\frac{5}{8}^{\circ}$. Their total enclosed ballbearing motors are normally supplied with ratings from $\frac{1}{2}$ to $\frac{1}{6}$ HP while the pump units have capacities of 20 to 45 GPH at 200 PSI.

Series 48 units, measuring 7% "x10%", are normally supplied with totally enclosed, fan-cooled motors of either split phase, capacitor, or 3 phase construction . . . with ratings from $\frac{1}{4}$ to $\frac{1}{2}$ HP. They can be supplied with pumps with capacities from 20 GPH to 360 GPH at 200 PSI.

Series 56 units measure $6^{11}/_{16}$ "x 11^{23} 2", and are offered in a complete range of motors varying from $\frac{1}{4}$ to 1 HP. These can be coupled with pumps with capacities from 20 to 360 GPH at 200 PSI.

SERIES 56

616

1123**

Although motors are normally furnished for 1725 RPM they are also available for 3450 and 1140 RPM. Explosion proof construction and double shaft extensions on motors are also furnished in series 48 & 56. Built-in relief valves are optional on all five pump sizes.

Special construction for OEM applications

The units shown plus ethers in Tuthill's line are immediately available without any quantity restrictions whatsoever.

For those original equipment applications involving substantial quantities, Tuthill's engineers can design and build a POWERMITE . . . an exclusive Tuthill design in which pump and motor are combined in one unit which takes up no more space and weighs no more than a standard electric motor. As an example of the compactness possible a Tuthill POWERMITE now being supplied for a hydraulic application measures only 4¾"x8½", yet has a capacity of 16 GPH at 350 PSI.

Tuthill's field engineers will be happy to provide details on the complete Tuthill close-coupled line and its application to your particular problem. If you are trying to fit a pump and a motor into a tight space you should talk to them soon. Call today.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 GPM; for pressure to 300 PSI; speeds to 3600 RPM.



TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois



The Clad 55 motors with THERMO-TECTOR system

WARRANTED

against burnout from overheating

For the first time General Electric offers you a motor with such positive protection it is WARRANTED in writing against overheating burnout!

G.E.'s exclusive new THERMO-TECTOR system gives Tri-Clad '55' motors truly inherent over-temperature protection.

G.E.'s exclusive new THERMO-TECTOR system gives Tri-Clad '55' motors truly *inherent* over-temperature protection. Unique variable shut-off feature allows motor to deliver *full* power potential under all operating conditions. Fail-safe THERMO-TECTOR system has simple, two-lead hookup. For the first time
General Electric offers
you a motor with such
positive protection
it is WARRANTED against
overheating burnout

HEAT-SENSING SWITCHES



Trade-mark of General Electric Co.

TURN PAGE FOR FURTHER INFORMATION :

NOW-A Motor Warranted in Writing Against Overload Burnout!

General Electric Company warrants to the Purchaser that the Tri-Clad '55' motor with Thermo-Tector system delivered hereunder

- (a) Not burn out because of everheating resulting from everload, lack of ven-tilation, single-phosing, stall, high em-bient, or veltage unbalance, as long as the Thermo-Tector writches are connected into the control circuit so that power to the motor is removed when an ever-temperature condition occurs;
- (b) Be free from defects in material, work-manship and title; and

(c) Be of the kind and quality designated or described in the contract.

The foregoing warranty is exclusive and in lieu of all other warranties whether written, oral, or implied (including any warranty of merchantability or fitness for purpose). If it appears within one year from the date of shipment by General Electric Company that the equipment delivered hereunder does not meet the warranties specified above and the Purchaser notifies the General Electric Company shall thereupon correct any defect, including non-conformance with the specifications, at its option,

either by repairing any defective part or parts or by making available at the General Electric Company's plant, a repaired or replacement part.

The liability of the General Electric Company to the Purchaser (except as to title) arising out of the supplying of the said equipment, or its use, whether on warranty, contract or negligence, shall not in any case exceed the cost of correcting defects in the equipment as herein provided and upon the expiration of said one year, all such liability shall terminate. The foregoing shall constitute the sole remedy of the Purchaser and the sole liability of the General Electric Company.

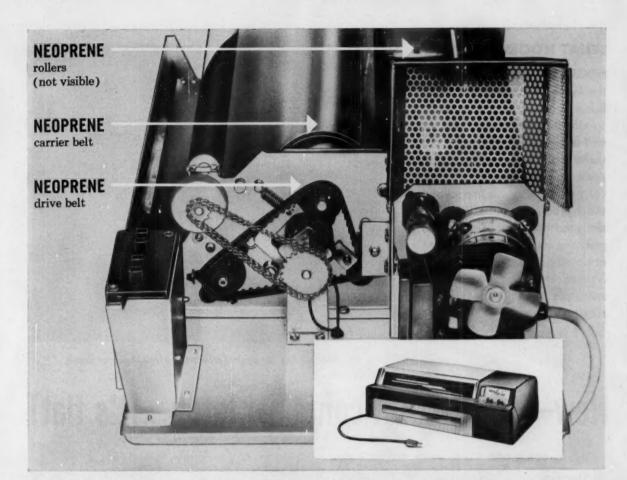
General Electric's exclusive THERMO-TECTOR system is available now on all Tri-Clad® '55' motors in frames 254U-445U. Contact your General Electric Apparatus Sales Office or Authorized Distributor today for details on this NEW FULLY WARRANTED MOTOR PRO-

TECTION SYSTEM. Or, write for Bulletin GEA-7092, Section 866-04, Schenectady 5, N. Y.

SMALL AC MOTOR & GENERATOR DEPARTMENT

GENERAL (28) ELECTRIC

Circle 629 on Page 19



In new photocopier...

NEOPRENE PARTS GIVE "BEST ALL-AROUND PERFORMANCE"

In designing the new "Auto Stat" photocopy machine, engineers at the American Photocopy Equipment Company, Evanston, Illinois, specified neoprene exclusively where rubber parts were required. Included are such key components as: printer belt, carrier belt, drive belt, processor rolls and paper transport rolls.

"Neoprene gave us the best all-around performance of any material we tested," reports an Apeco engineer. "We found, for example, that it's highly resistant to the corrosive action of caustic developer chemicals. It withstands ozone exposure without cracking or crazing. In rollers and wheels, neoprene resists compression set, and in belting it holds its size and shape."

No other general purpose rubber can equal neoprene's balanced combination of properties, or match its resistance to so many deteriorating factors. Neoprene assures longer service life for equipment because parts stay lively and resilient over years of operation. What's more, parts made of neoprene will not support combustion.

If you'd like to learn more about the many ways neoprene is solving design problems in everything from household appliances to equipment for business and industry, write for a free copy of "An Engineering Guide to the Du Pont Elastomers." E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department MD-10, Wilmington 98, Delaware.



SYNTHETIC RUBBER

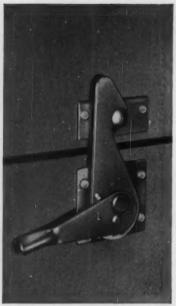
NEOPRENE HYPALON® VITON® ADIPRENE®

Better Things for Better Living . . . through Chemistry

WHAT HOOK-LOCK IS

HOOK-LOCK is a springless, positive-locking latching device which is ideally suited for use on rigidly specified military transit cases as well as less expensive commercial containers. It provides high closing pressure and tremendous load-carrying capacity...is impact and shock-proof. HOOK-LOCK is so designed that it lies flat against the mounting surface whether in open or closed position. Since operation is parallel to mounting surface, no space for operating clearance is required.





HOOK-LOCK lies flat against mounting surface, open or closed.

New-HOOK-LOCK container latch...It's flat!

FEATURES

Shock-proof—solid construction...withstands high impact blows directly on the fastener.

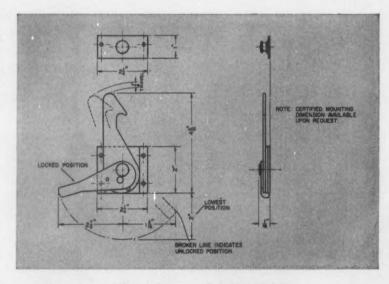
Closing pressure of 200 lb. Where needed, pull-down pressure can be substantially increased by modification of operating lever.

Tensile load capacity: 750 lb.

Compact—lies flat open or closed. Extends just 7/16" from container surface at thickest point.

Positive-locking and springless. Unaffected by arctic temperatures.

No operating clearance required, because hook and lever move parallel to mounting surface.



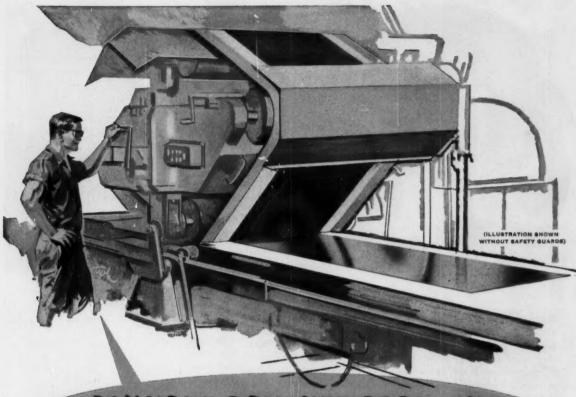
IF YOU have questions regarding the possible application of HOOK-LOCK or other Simmons industrial fasteners to your particular needs, your inquiry will receive our immediate attention. Contact your nearest Simmons office or write direct.

SIMMONS

1756 North Broadway, Albany 1, New York

FASTENER CORPORATION

See our 8-page catalog in Sweet's Product Design File



ASK YOUR POLISHER ABOUT THE DIFFERENCE IN STAINLESS SHEET

ALLEGHENY LUDLUM SHEET sets the standard for surface quality. Polishers will tell you—they handle all kinds and they should know. They want stainless sheet without flaws, a smooth surface ready to take further polishing to meet specs.

For stainless sheet delivered to the polisher with an irregular surface, or containing flaws, needs extra work that takes time and adds to cost—even causes loss of thickness.

That's why the polishers prefer to work with A-L stainless sheet. For A-L stainless sheet is always smooth . . . a surface without flaws . . . quality stainless, order after order. Your polishing department will also give an enthusiastic reception to stainless sheet from Allegheny Ludlum. Polishers think more of A-L stainless sheet—they will think more of you for ordering it for them. Remember, the pay-off is in the polishing.

For consistent temper, tolerances, and finish in flat rolled stainless products, call your Allegheny Ludlum salesman, or write: Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania. Address Dept.MD-101.



ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS ... EVERY HELP IN USING IT





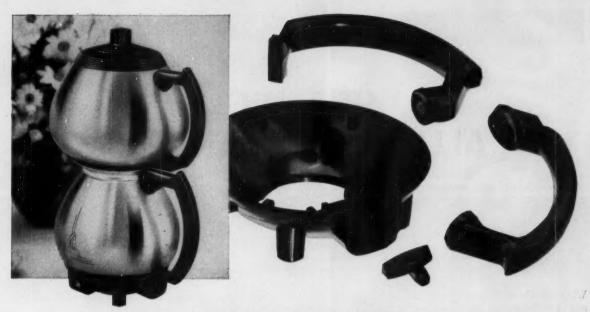
Molded Vinyl Provides Flexibility and Color Harmony in Steering Wheel Grommet. Color matching without painting, flexibility as needed—these are two advantages BAKELITE Brand vinyl offers in these grommets for Mercury cars. Used to enclose the steering column at the instrument panel, the grommets are molded in colors to harmonize with car interiors. Flexibility of the vinyl permits the grommet to fit snugly and eliminate road vibration. A cost saving over the rubber used previously was another important advantage.

FOR A FRESH NEW LOOK,



Colorful High-Impact Styrene's Light Weight Makes This Portable Sewing Machine Easier to carry.

Durability and a pleasing appearance enhance the sales appeal and service life of the carrying case for Singer's new portable sewing machine. The BAKELITE Brand high-impact styrene plastic cut four pounds from the weight of the old-type case, and gives a high-gloss finish in lasting color. Moldability of the BAKELITE high-impact styrene proved best of several plastics tested before production began. Matching base and accessory box are molded from the same material.



Phenolics Improve Looks and Service Life of an Automatic Coffee Maker. Main considerations in the design of this utensil were attractive appearance and heat resistance. Bakelite Brand phenolics met both requirements at low cost. Base, handles, and upper rim were molded from phenolic resins developed by Union Carbide Plastics Company. They don't warp or blister and keep their lustrous finish even though frequently exposed to hot fumes and coffee grounds.

REDESIGN IT IN PLASTIC

When your product must be handsome as well as efficient, molded plastic components can give it fresh eye-appeal and durability that influence buyers

Is the sale of your product hampered by an unattractive or outmoded appearance? Then start anew, and design it freely, according to your ideas of what it could look like. You have more freedom when your design calls for fabrication with Bakelite Brand plastics. Choose from numerous Bakelite Brand plastics—polyethylenes, epoxies, phenolics, styrenes, and vinyls—all are high quality, and offer you a wide range of properties. You can get colors, impact strength, heat and ultraviolet resistance, light weight; plus the fabricating characteristics you need. And more than likely you'll realize a cost saving besides.

See your Sweet's Product Design File, Sec. 2a/ui for properties of BAKELITE Brand plastics. For specific information, just mail the coupon.

BAKELITE and UNION CARBIDE are registered trade marks of Union Carbide Corporation.

Dept. DF-84,
Union Carbide Plastics Company
Division of Union Carbide Corporation
270 Park Avenue, New York
Please send me details about BAKELITE Brandplastics for molding applications. Application,
being considered is

NAME
FIRM NAME

CITY ZONE STATE

SEALING ALUMINUM FLANGES

As heat expands aluminum flanges, gaskets often crush and extrude and bolt loading is reduced. New engineering research points way to better seals on these flanges.

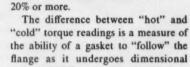
E. M. SMOLEY.

Research Physicist
Armstrong Research and Development Center

Where aluminum flanges are used... and particularly where they are exposed to alternate cycles of heat and cold... crushing and extrusion of gaskets and serious loss of bolt torque are often encountered.

creasing the unit load on the gasket. The consequent crushing and extruding of the conventional fiber gaskets led to substantial loss of bolt torque.

The study also turned up other data unique to aluminum flanges. This is the



num, however, the difference often is

flange as it undergoes dimensional change. Ideally, a gasket should show no difference between hot and cold torque readings. It should resist crushing under high pressures and high temperatures—and it should compensate for the contraction of the flange as it cools.

Because conventional materials fall short of these requirements, Armstrong engineers set out to develop a new type of gasket. Their work resulted in a new beater-saturated asbestos material—Accopac AN-890. This new gasket resists crushing under pressures of 100,000 psi at temperatures up to 350° F., and it has superior torque retention characteristics.

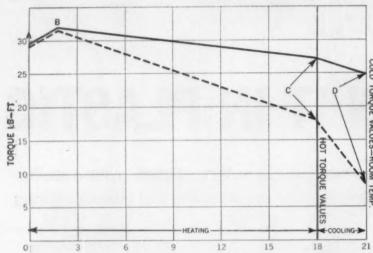
If you have a problem with gasket seals on aluminum flanges, our research may be helpful to you. We will be glad to make suggestions if you will submit details of your problem to us.

Much detailed information on other problems of gasket design, selection,

and performance is contained in the Armstrong Gasket Design Manual. Write today for your copy of this 32-page book.



Address Armstrong Cork Company, Industrial Division, 7110 Dean Street, Lancaster, Pennsylvania.



TIME-HOURS

This diagram shows effect on torque retention of thermal cycling to 300° F. of gasketed joint with one aluminum flange and one cast iron flange. Torque increase from A to B results from aluminum expansion; B to C represents normal torque loss at constant oven temperature; C to D is loss

To study this problem, Armstrong engineers set up simulated service tests with stock automotive transmission housings. These housings all have large aluminum members that are subject to wide variations in temperature, and all require high flange pressures.

The initial result of the tests indicated—as expected—that the expansion of the aluminum had the effect of inresulting from aluminum contraction. Solid line is average result of tests with Accopac AN-890, which retains about 90% of the original bolt torque. The dotted line represents average test results with conventional gaskets, which retain only about one-third the initial torque loads after cycling.

difference between "hot" torque readings—taken while the transmission is at 300° F. and "cold" readings, taken after the assembly cools. With iron or steel flanges, there is no significant difference between these readings. With alumi-

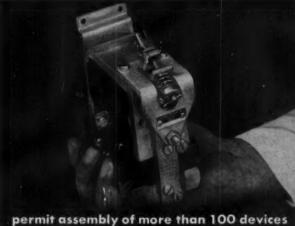
Armstrong GASKET MATERIALS

1860-1960 Beginning our second century of progress









GENERAL ELECTRIC OFFERS

building-block" d-c contactors and relays

General Electric's new line of d-c contactors and relays features a new concept in component design-buildingblock construction. Using front-connected frame and coil parts, standard assembly kits, and "universal" contact blocks, more than 100 different control devices can be assembled. This new design concept makes possible these important cost-saving advantages:

Reduced inventory-with building-block design, you need to stock only a minimum number of standard parts. Not only does this mean less costly inventory, but valuable storage space can be released!

Immediate availability-with General Electric devices, the contactor or relay you want can be assembled on the spot! No need to order a specific device and await delivery, or stock a large number of special ratings. Assemble what you want-when you want it!

Order today from General Electric's

complete line of stock d-c contactors and relays featuring the new buildingblock construction.

NEED OTHER COMPONENTS?

General Electric also has complete lines of plate rheostats and vitreousenameled resistors for all your control needs. For more information, contact your General Electric Sales Representative or mail this coupon today! Industry Control Dept., Salem, Va.



Circle 455 on Page 19

ues from stock, fixed or slide-wire, 5 to pletely encased in metal to give longer and 200 watts. Call your G-E representative. more reliable service for any application.

Vitreous-enameled resistors-1070 ohmic val- Plate-type rheostats-windings are com-





General Electric Co. Schenectady 5, N. Y.

Please send the following bulletins:

- ☐ GEA-6621—D-c contactors and relays
- ☐ GEA-6592—Vitreous-enameled resistors
- ☐ GEA-6474—Plate-type field rhoostats

To: Section F784-25

REPUBLIC COLD EXTRUSION QUALITY STEEL

... steel that cuts your cost of production

Republic Steel—largest producer of the nation's widest range of bar products—has a new, 11" bar mill in Chicago that specializes in steel for cold extrusion and cold heading. Features that save you money:

- UNIFORM FLOW CHARACTERISTICS—carbon and alloy steels produced on this mill have denser, more uniform structures because they undergo more hot work. Bigger than usual billets, 3" and 4" square, become finished products of standard size.
- PRECISE DIMENSIONAL ACCURACY—16 alternating vertical and horizontal stands with roll neck bearings are utilized to exert uniform pressure on all sides of the bar. This process, along with vertical looping above the mill, eliminates deformations.
- ANNEALED, NORMALIZED, SPHEROIDIZED—new continuous annealing furnaces, capable of all types of furnace treatments, are designed for rigid control of speeds, temperatures, and atmospheres. Other facilities are available to pickle, oil, lime, phosphate, and borax coat bar products.
- 4 1600-POUND, DOUBLE-BANDED COILS—four high-speed coilers handle the complete range of coils produced (%" to 8%4"—700 to 900 pounds, %" to 1½"—1400 to 1600 pounds). Bigger coils cut downtime and scrap loss. Double banding simplifies your handling.
- 5 CAPACITY TO MEET YOUR REQUIREMENTS—this 11" bar mill produces bar products at rates of up to 3000 feet per minute. Annealing furnaces are the continuous type, capable of meeting the growing demand for furnace-processed steel.

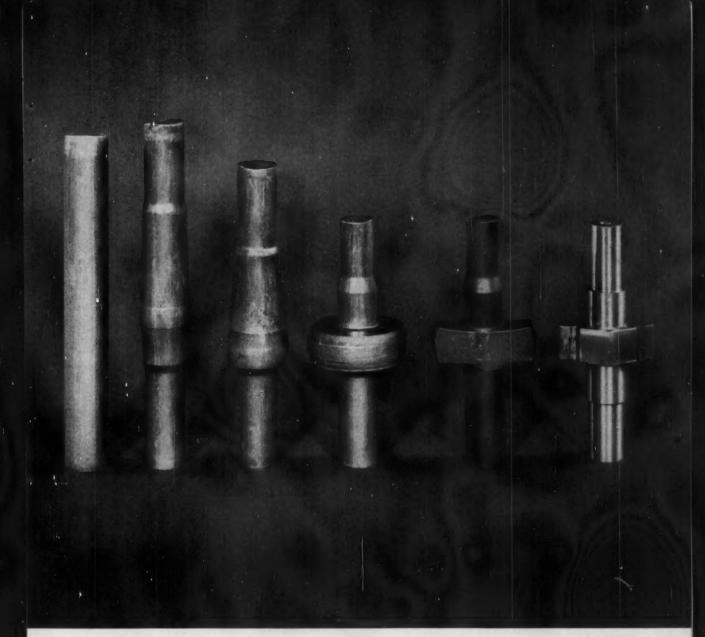


COLD FINISHED, TOO!

Depending upon the nature of your product and the method by which it is made, you may find it more advantageous to use cold extrusion quality steel in *cold finished form*, as did the manufacturer of this gear.

Circle 456 on Page 19

We would welcome an opportunity to serve you on your requirements for both bot rolled and cold finished, cold extrusion quality steel. Our metallurgists will help you select the most economical carbon, alloy, or stainless steel capable of meeting your requirements. For complete data, call your nearest Republic sales office or mail the coupon.



CUTTING THE COST OF A SEGMENT GEAR: ideal blanks are produced by cold heading, cold extrusion, and upsetting. Stock with upset in the center is hot trimmed on a press, after which it is machined into the finished part. Only a minimum of stock need be removed during final machining. Photo courtesy of National Machinery Company, Tiffin, Ohio. Circle 457 on Page 19



REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

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REPUBLIC STEEL CORPORATION DEPT. MD-1131

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Send more information on cold extrusion and cold heading

☐ Hot Rolled

☐ Cold Finished

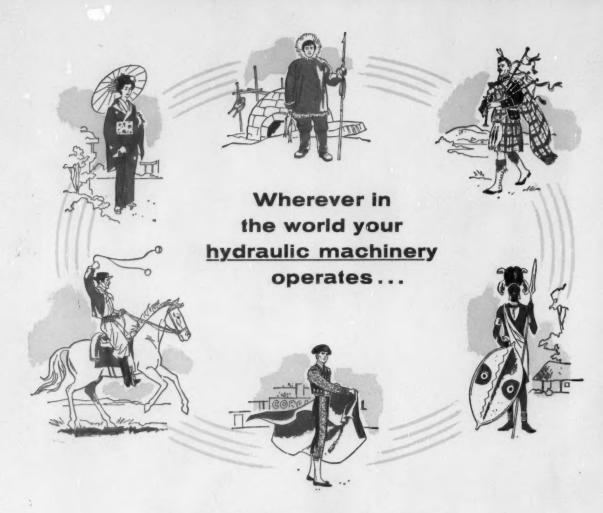
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Shell Dromus Oils—soluble cutting oils for high-production metalworking

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industrial gear lubrication

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No matter where your hydraulic machinery is shipped, make Shell Tellus Oil your standard recommendation. Write for complete information.



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SHELL OIL COMPANY



WEAR RESISTANT THOMSON

60

AVOID the HIGH COST
and difficulty of fabricating
long, hard & straight
parts by
conventional
methods!

hardened and ground

SHAFTS, ROLLS, GUIDE RODS and other long-round parts · ELIMINATE WEAR and REDUCE COST

of over 15 years of experimental work and production experience with hardened and ground shafts which are a requirement for BALL BUSHINGS, the Linear Ball Bearing manufactured by Thomson Industries, inc.

The special techniques and equipment that have been developed enable high production rates and low handling costs. This permits big savings over conventional methods which are plagued with erratic warpage, straightening and resultant grinding problems. Finished 60 Case parts frequently cost less than the scrap losses that result from conventional methods.

60 Case material has a surface hardness close to 60 on the Rockwell C scale which is essential to resist wear.

Long lengths of material ranging in diameter from ¼" to 4" are stocked to enable prompt shipment of 60 Case parts, with or without special machining. Write for literature and name of your local representative.

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- . GROUND FINISH
- HARD BEARING SURFACE
- . STRAIGHT PARTS
- . NICK-& DENT-PROOF
- . DELIVERY FROM STOCK
- ACCURATE DIAMETERS
 ADDED STRENGTH
 UNIFORM HIGH QUALITY

TYPICAL 60 Case PARTS

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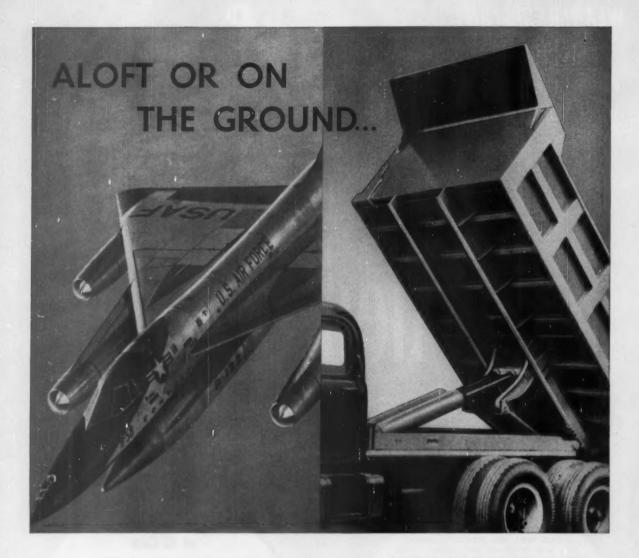
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Circle 459 on Page 19

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Koppers Sealing Rings give ensured actuation!

Koppers solves diverse and difficult sealing problems.

Modern supersonic jets and dump trucks—as dissimilar as they appear—both depend on Koppers Sealing Rings for efficient hydraulic system operation. Koppers Predictable Performance Sealing Rings are used in a wide variety of applications... engineered to satisfy each requirement of both hydraulic and pneumatic sealing.

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DOT。 NYLON PUSH-IN NUT

- Non-corroding
- Electrical insulator
- High pull-out resistance
- Straight legs won't distort thin, soft materials

This versatile fastening device snaps into place under finger pressure alone. Its straight legs permit easy insertion in square, punched holes while the tapered screw hole forces the legs apart when screw is inserted and ensures maximum pull-out resistance. Burrs do not impede the nut or prevent proper seating.

Ideal for use in virtually any type of thin-walled structure of sheet metal or plastic, the DOT Push-in Nut does not chip enamel surfaces, locks tightly without distorting the edges of the hole, resists vibration and serves as an excellent electrical and thermal insulator.

Suitable for use with #8 or #10 screws...locks in holes from .275" to .292" square...application thickness range: .030" to .060". Spacer type available with $\frac{1}{2}$ " dia. head from $\frac{1}{6}$ " to $1\frac{1}{12}$ " length in increments of $\frac{3}{32}$ ". Other types available in various sizes, round or square-headed, from $\frac{1}{32}$ " to $\frac{1}{6}$ " thick.

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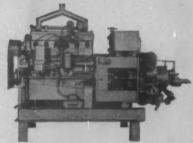




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"Proven reliability of International engines has led to the universal acceptance of Ready-Power air conditioning equipment" Report from Norb Hall, Manager, Air Conditioning, Ready-Power Co.







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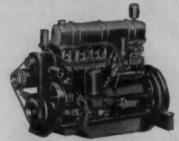




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"International engines help give all four models of our earth augers fast digging action, high speeds coming out of the hole, and clean throw-off:" Report from H. B. Williams, President, Hugh B. Williams Manufacturing Co.







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Efficient and dependable power is assured for products of leading engineers, who specify IH engines for a wide variety of applications. Design engineers serve many different industries, but they all have one common problem: to find the most practical, economical and efficient power for their products. If you have the responsibility for selecting the power for your products it will pay you to check International engines because-

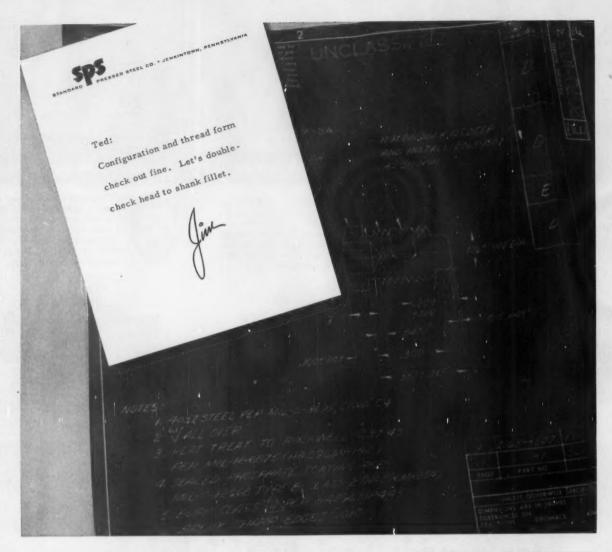
FIRST, you have a wide selection of power from which to choose-35 engines from 16.8 to 385 max. hp-available in gasoline, LP gas, natural gas or diesel.

SECOND, IH engines meet rigid requirements of economy and dependability. Millions of hours of continuous operation in all parts of the world have job-tested International power on every heavyduty application.

THIRD, your customers never have to wait for replacement parts. International's world-wide parts and service facilities back up your organization with fast assistance on power problems.

Check the complete line of IH engines now, and discover the extra selling advantages International power adds to your product. Call or write to International Harvester Co., Engine Sales Dept., Construction Equipment Division, Melrose Park, Ill.

180 North Michigan Ave., Chicago 1, III. A COMPLETE POWER PACKAGE



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When SPS quotes on your special threaded fastener, you get more than just an accurate estimate of cost. You also get design confirmation. Our engineering and methods people not only interpret your prints and specs; they also analyze them—carefully. And if they have any questions (socket depth, fillet radius, etc.), they double-check with you.

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From extreme specials to near-standards, SPS can meet almost any conceivable requirement you may have in configuration, material, thread form, finish or tolerances.



OEM Guide to Electric Heaters

How to select the exact heating element to meet your product requirements

Here's condensed information from General Electric to help you get the most economical heater for your products,



CARTRIDGE

Applications-Efficient, self-contained

in process machinery and for localized heating requiring close thermal control: dies, platens, molds, extrusion and injection barrels, gluepots, compound pots.

• Features—Durable nickel-chromium re-

sistance wire packed in insulation and sheathed in metal tube.

• Ratings-30 to 2800 watts-Sheath temperatures: brass (750F); nickel-silver (1000F); chrome-steel (1200F)—Over-all lengths: 1½ in. to 2 ft.—Diameters: 3% in. to 1.293 in.-115v to 230v.



THMERSION HEATERS

· Applications—Offer clean, economical method of heating various liquids in

tanks, kettles, jack-ets and other containers. Suitable for immersion in water, oil, alkaline solutions, nickel, copper, chrome, plating solutions, mild sulphuric acid baths and salt baths.

• Features-Long life-Easily installed-Easily controlled-Sealed terminals-Excellent insulation and heat conduction.

• Ratings-Both through-the-side and over-the-side models available—Sheath materials: copper, nickel-silver, stainless steel, Inconel and lead—115v to 230v— Wide variety of models from 650 to 10,000 watts.



FIN TUBULAR MEATERS

• Applications — Especially suited to forced-convection air heating applications, such as air ducts with

forced-air circulation, blower-type electric unit heaters, car heaters, recirculating ovens, industrial processes requiring heated air blasts for drying, baking, testing or pre-heating.

• Features-Large radiating surface per unit length—Fins sturdily attached by brazing—Quick heat transfer—Nonoxidizing rust-resistant finish-Durable con-

-Wide variety of shapes available—Sheath temperature: steel (850F) -Watts: up to 100 per linear inch.



TURULAR

Applications-Applicable to practically every low-tem-perature (1500F or

lower) requirement, whether heating liquids, air, soft metals, or metal surfaces. Typical applications: ovens, ducts, platens, pipes, space heaters.

Features-High-quality resistance wire, insulated in metal tubing-Heaters bent to conform to almost any shape, cast into metal, located in drilled holes, grooves, or spaced away from surfaces.

• Rotings-Standard ratings, 500 to 5000 watts; special ratings available—Sheath materials: steel (750F); nickel-silver (1000F); stainless and Inconel (1500F); copper (212F in water).



STRIP HEATERS

· Applications-Designed for direct clamping to surfaces. Typical applications: process machinery,

drying ovens, matrix scorchers, warming tables, glue tables, water baths, drying cabinets, pipelines, incubators, valve and pump houses, telephone switchboards, roll heating, packaging machinery.

Features-Uniform heat distribution-Corrosion-resistant sheath materials— Easy to install—Moderate cost—Uniformity.

• Ratings-Provided with offset terminals at one end or terminals at each end-Sheath materials: Aluminized-steel (1000F); Chromized-steel (1200F).



METAL-MELTING HEATERS AND POTS

· Applications—Feature cast-in immersion heaters for melting lead, babbitt, tin,

solder, type metal and similar metals up to 950F. Applica-tions: dip soldering of subassemblies, railway and repair shops, electric service shops, printing plants, manufacturing plants, remelting metals.

-Heat generated right in metal for quick heating, low radiation losses— Heater easily replaced without interrupting production—Reliable, safe, economical—Can be tied in with automatic

• Ratings-Standard melting pots-Wt. 50 to 2000 lbs-Watts: 750 to 30,000.



OVEN HEATERS

· Applications-Designed for such applications as baking, japan, foundry cores, drying, low-tempera-

ture drawing ovens, and for general air heating applications in which there is free movement of air by convection. Heaters used in recirculating type ovens for core baking, paint drying, tempering, air heating in ducts, placement inside oven.

• Features—Easily mounted on side walls of oven or in ducts-Wide range in heater ratings and combinations of heat-

• Ratings-Temperatures: Two models available: 750F-1000F, and up to 1200F.



VANE-TYPE HEATERS

• Applications—Used for air and surface heating applications: baseboard heaters, pipe heating, platen

heating, valve and pump heating, drying cabinets and ovens, process machinery, compound tanks.

• Features-Rugged tubular construction resists mechanical shock and vibration— Large, 134 in. wide radiating surface-Low heat density: 25 watts per linear in. of vane; 14.3 watts per sq. in. of heater surface Can be easily formed-Convenient mounting holes.

• Ratings-Variety of models from 500 to 2500 watts—115 to 230 volts—Over-all lengths: 24 to 104 inches—Maximum operating temperature 750F.



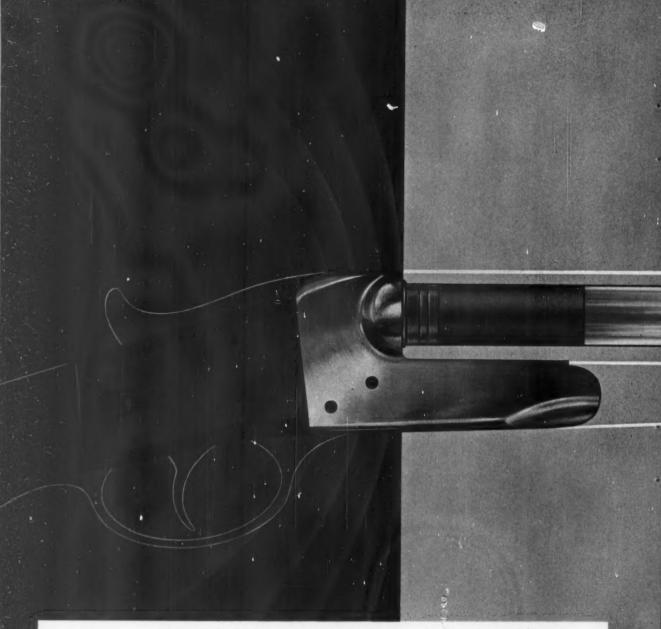
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Pressure on the face of this Malleable iron receiver approaches 5 tons per square inch each time this 12 gauge shotgun is fired.

For Really Tough Parts...Use Malleable

With high powered charges being fired just inches from your face, you don't want parts that can't take it. That's why so many weapon parts are made of tough Malleable iron castings.

Tremendous resistance to impact, fatigue, deflection, and wear also makes Malleable castings favorites among manufacturers of mining and construction equipment, heavy-duty tools, and other products that require extra tough components.

Have you investigated how Malleable castings will improve your product's performance and cut costs at the same time? If not, send drawings or outline of your requirements to a nearby Malleable castings producer who displays this symbol —

MALLEABLE

For detailed information on "Toughness", contact any of the progressive companies listed on the opposite page, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

Malleable Assures Toughness and Dependability for Torsion Arms

Torsion arms are the vital link between the violent motion of the wheels and the resisting force of torsion bars. Tough, dependable Malleable iron castings are used for torsion arms by every manufacturer of vehicles that employ torsion bar suspension systems. Malleable castings take this kind of punishment without failure.

First, Malleable's modulus of elasticity provides the rigidity necessary to resist deflection under heavy loads. Second, Malleable castings' high ratio of yield to tensile guarantees plenty of reserve strength, even for torsion arms on trucks used continuously for off-the-road service.

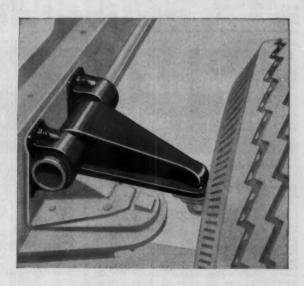
Tensile Properties—A.S.T.M. Minimum Specifications Standard and Pearlitic Malleable Irons

Designation	Tensile Strength p.s.i.	Yield Strength p.s.i.	Elongation % in 2 in.
Standard	practi	positi	
35018	53,000	35,000	18
32510	50,000	32,500	10
Pearlitic			
45010	65,000	45,000	10
45007	68,000	45,000	7
48004	70,000	48,000	4
50007	75,000	50,000	7
53004	80,000	53,000	4
60003	80,000	60,000	3
80002	100,000	80,000	2

Strengths up to 135,000 p.s.i. tensile and 110,000 p.s.i. yield are produced commercially under individual producers' specifications.

Other Mechanical Properties Standard and Pearlitic Malleable Irons

	Standard	Pearlilic
Modulus of Elasticity in Tension, p.s.i.	25,000,000	25,500,000-28,000,000
Ratio of Fatigue Strength to Tensile Strength	0.54	0.40-0.50
Shear Strength—% of Tensile Strength	80-90%	70-85%
Torsional Strength	Approximatel	y equal to Tensile Strength
Compressive Strength, p.s.i.	200,000	250.000



In addition to their proven toughness and stamina, Malleable castings are outstanding for manufacturing economy. Modern casting methods produce parts so close to finished shape that surplus metal is reduced to the minimum. Malleable saves time and tools in machining because no material of comparable properties machines so easily and quickly.



FREE ENGINEERING GUIDE

A condensed synopsis of engineering data plus case histories that may suggest ways for you to improve your products is available from any member of the Malleable Castings Council, or from the Council's offices, Union Commerce Building, Cleveland 14, Ohio. Just ask for Data Unit No. 105, "Toughness."

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Eastern Malleable Iron Co., Wilmington 99
1LLINOIS

Central Fdry, Div., Gen. Motors, Danville Chicago Malleable Castings Co., Chicago 43 Moline Malleable Iron Co., St. Charles National Mall. and Steel Castings Co., Cicero 50 Peoria Malleable Castings Co., Peoria 1 Wagner Castings Company, Decatur INDIANA

Albion Malloable fron Company,
Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22
IOWA

Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS

Beicher Maileable Iron Co., Easton MICHIGAN

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Northern Malleable Iron Co., St. Paul 6 MISSISSIPPI

Mississippi Malleable Iron Co., Meridian NEW HAMPSHIRE

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Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division
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OHIO

American Malleable Castings Co., Marion Central Fdry. Div., Gen. Motors, Defiance Dayton Mail. Iron Co., Ironton Div., Ironton

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TEXAS

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(Advertisement)	Asbestos	All Rubber	Misc.		Asbestos	All Rubber	Misc.
Resistance Ratings A = Good F = Fair C = Depends on conditions X = Unsuitable CAUTION: Do not use table without reading text.	Compressed sheet Woven rubber Woven neoprene	GR-S Neoprene Buna-N Butyi Natural	Plant-fiber sheet Teflon	Resistance Ratings A = Good F = Fair C = Depends on conditions X = Unsuitable CAUTION: Do not use table without read- ing text.	Compressed sheet Woven rubber Woven neoprene	GR-S Neoprene Buna-N Butyl	Plant-fiber sheet Teflon
Acetic acid, crude pure vapors 150 p.s.l., 400 deg. F. Acetic anhydride Acetone Acetylene Air Aluminum chloride Aluminum sulphate Aluminum sulphate Aluminum sulphate Aluminum horoxide Ammonium chloride Ammonium hydroxide Ammonium phosphate, monobasic cribasic Ammonium sulphate Amy acetate Amyl acetate Barium chloride Barium sulphide Barium sulphide Beer Beet sugar liquors Benzene, benzol Benzine, petroleum ether, naphtha Black sulphate liquor Blast furnace gas Borax Boric acid Bromine Butane Butyl acetate Butyl alcohol, butanol Calcium bysochlorite Calcium hydroxide Carbon dioxide, dry wet Carbon bisulphide Carbon monoxide, hot Carbon tertachloride Carbon dioxide, dry wet Chlorinated solvents, dry Carbon bisulphide Carbon monoxide, hot Carbon tertachloride Carbon monoxide, hot Carbon tertachloride Carbon monoxide, hot Carbon tertachloride Carbon monoxide, hot Chlorinated solvents, dry E Ethers Ethyl acetate Ethyl cellulose Ethyl chloride Forma acid Freon Fuel oil Fuel oil, acid Freon Fuel oil Fuel oil Fuel oil Fuel oil Fuel oil Fuel	CCF AAAA AAAA CAAAAAAAAAAAAAAAAAAA	CCCX -FAAAA -AAACCACAAAAAAAAXXXACCAAXXXACCAAXXXAACCAAXXXXXX	FFFX CCA ACXF CA F F AAAAXXA XXCX AFF F XXXCCACXXXX XCFX ACXXX XXXAXCA F CX X XAACAAAAAAAAAAAAAAAAAAAAAAAA	Hydrogen sulphide, dry, cold hot wet, cold hot wet, cold hot hot wet, cold hot hot wet, cold hot hot wet, cold hot Linseed oll Lacquers solvents Lacquer solven	ACCAAAAAAACAC-AAAAAACCXXXXXA	CCCCCCXXCCCCFFAAAA - ACACFAAAXXXXF FCC X FCCXCCCCCCAAAAA CCAAAAAAAAAAAAAAAAAAAAA	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Chemical Resistance of Gasket Materials

This chart enables you to select accurately the right "U.S." Gasket for corrosive service

SEND FOR YOUR FREE REPRINT NOW

The chart will be useful in indicating the degree of safety with which the various materials may be used in the service shown.

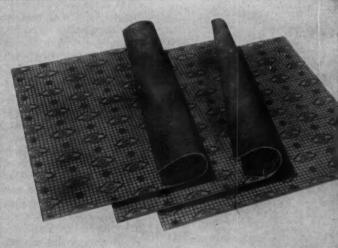
Those materials known to be suitably resistant have been rated as "A". Those whose resistance is only fair, but not so low as to be dangerous, have been given an "F" rating. An "X" denotes that the material is totally unsuitable. The "C" rating means that the use of this material is dependent upon specific service conditions and should not be selected unless carefully investigated. The blank spaces for the most part represent absence of data.

The generally accepted temperature limit for a good

grade compressed asbestos sheet, also called asbestos composition sheet, is 750° F. However, some grades are successfully used at considerably higher temperatures. This type of sheet is used for smooth flanges. For rough flanges, gaskets cut from woven asbestosmetallic sheet or gaskets formed by folding asbestosmetallic cloth are preferred. The latter material is preferable for flanges when bolt pressures are necessarily limited to the type of flange material.

The all-rubber materials are recommended for temperatures up to 300° F. Higher temperatures are sometimes used but with a lesser degree of safety. Pressures are determined by the type of flange surface.





These are outstanding members of the "U. S." line of Sheet Packing — Nos. 899 and 9. They are recommended for packing flanges or other parallel surfaces against the many chemicals listed on the opposite page.

When you think of packing, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.



Mechanical Goods Division

United States Rubber

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DENISON hydraulic equipment powers 21 hatch covers and anchor windlasses aboard new "Export Agent"

CONTROL



National Steel and Shipbuilding
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precise, reliable Denison hydraulic equipment to power hatch
covers and anchor windlasses.
Variable
Volume Axial
Piston Pump

FIRST of the new replacement fleet for American Export Lines—the "Export Agent" is designed to carry over 643,000 cubic feet of general cargo. Largest and fastest cargo vessel now operated by A.E.L.—this ship is equipped with many new cargo handling devices...including 21 hydraulic hatch covers, powered by Denison hydraulic equipment.

The hatch cover system—built by Greer Marine, Inc., Catasauqua, Pa.—incorporates 500 Series Denison constant volume pumps. Operation is fast, simple and safe. Result: Important time savings in cargo handling plus minimum cargo damage in bad weather.

In addition, the anchor windlasses—supplied by The Hyde Windlass Co., Bath, Maine—are powered by Denison 60 Series handwheel-controlled variable volume axial piston pumps and fluid motors. Maximum fluid motor speed is 1150 rpm. Output of the pumps is 120 gpm at 1200 rpm. Result: Precise, accurate control and reliability for the anchor windlass system.

Denison hydraulic equipment is engineered to deliver low-cost fluid power for every marine need—steering systems...cargo handling...winch and windlass drives. Your nearby Denison Hydraulic Specialist can help you save time and money on your next marine hydraulics problem. Write for details.

DENISON ENGINEERING DIVISION

American Brake Shoe Company 1240 Dublin Road • Columbus 16, Ohlo

HYDRAULIC PRESSES
PUMPS · MOTORS · CONTROLS

DENISON HYDRAULIC POWER



appearances are not deceiving

THIS P&B 10-AMP RELAY IS AS RELIABLE AS IT LOOKS

Our AB relay looks rugged . . . and it is. You can specify it for 10 amp switching and confidently expect 100,000 cycles. Yet it is compact, easily mounted, and does not require special handling. Installation is simple, using your preference of screw

terminals (adapters), quick connects, or dip soldering.

Designers specify the AB for air conditioners and other products where dependable, continual service is paramount.

These standard AB and ABC relays are listed by Underwriters' Laboratories and Canadian Standards Association:

Type Arrangements
AB7AY DPST-NO
AB8AY DPST-NC
AB11AY DPDT

Cail valtages: 6, 12, 24, 115 and 230 volts AC, 50/60 cycle. Centact rating 10 amps, 115 volts AC or 5 amps, 230 volts AC noninductive.

U/L File E-29244 CSA No. 15734

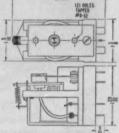
Write for complete data or contact your nearest P&B sales engineer.

AB AND ABC RELAYS ENGINEERING DATA

GEMERAL:
Insulation Resistance: 100 megohms minimum
Life: 3 million cycles (mechanical).
Breakfown Veltage: 1500 volts: rms between
all elements and ground.
Temperature Range: DC: -55 to +45°C.
AC: -55 to +45°C.
Weight: AB--5 ozs. ABC--7 ozs.
Terminals: Fit ½" quick-connect terminals,
or may be applied to printed circuits
using dip soldering. Screw adapters
furnished on request.
Endissum: ABC: Heavy duty dust cover.
Dimensions: 11½6" x 27½½" x 2½2".
- OUTLATEC.

CONTACTS:

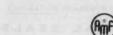
Arrangements: DPDT Material: ¼" dia. silver. Other materials available.
Lead: 5 amps at 230 volts AC or 10 amps at 115 volts AC noninductive.
10 amps at 28 volts DC.



ohms max. : DC coils will withstand

AB: Two 8-32 tapped holes on 1¼" centers. ABC: One 8-32 stud ¾" long and locating tab.

P& B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL **ELECTRONIC PARTS DISTRIBUTOR**



ABC Series—AB series can be sup plied enclosed in sturdy metal dust cover, 131/44" x 231/22" x 23/22".

R & BRUMFIE

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

Circle 467 on Page 19

HANDIEST GUIDE FOR SEALING SPECIFIERS



You get all essential data—from basic approach to specification—for modern oil sealing practice, in this new Victor catalog. Every section offers valuable help in choosing the right oil seal and insuring effective performance on your application.

Convenient to use, this catalog gives you close-up exposition of standard structures—metal-encased, one-piece molded, and split seals. The general characteristics of synthetic rubber oil seal compounds are covered in detail, with service ratings. Specific recommendations are given on design adaptability in relation to sealing pressure, temperature, and shaft speed. All this in addition to a complete listing and size data

on all available standard-type Victor quality oil seals!

Your copy FREE on request

Depend on this new catalog to give you complete, up-to-date information for all your oil seal needs—standard or special. Write for your copy today—ask for Catalog No. 306.

If you have a special oil seal need, Victor's engineering staff and leading production facilities can help you fill it most economically. Talk it over with your Victor Field Engineer—no obligation.

Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill. Canadian Plant: St. Thomas, Ont.

VICTOR

Sealing Products Exclusively

OIL SEALS . GASKETS . PACKINGS . MECHANICAL SEALS

Some Ideas



for your file of practical information on drafting and reproduction...from

KEUFFEL & ESSER CO .-

When it comes to lettering—plain or fancy—professionals the world over turn to LEROY® Equipment by K&E. In drafting rooms, art departments—not to mention schools, business offices, churches, clubs, hospitals—LEROY has become almost as necessary as pencil and paper.

Truly, there's no magic about LEROY -

custom-made, to your design — as we have done for thousands of others.

A "Buitt-in" Pencil Point

The business of stopping work to put a sharp point on a lettering pencil is now largely over and done with, thanks to another new LEROY item. The point of the new LEROY "020" pencil never blunts or

uniform, and of exactly the same density (a careful balance, chosen to give good wear without sacrificing print-making quality). You never saw pencil work look so good.



The Pen With A "Built-in" inkwell

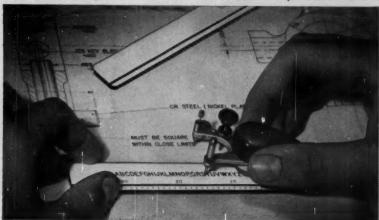
Here's your ticket to faster ink work with far fewer refills—K&E's new LEROY Reservoir Pen. You'll be amazed at the mileage you can get between refills with this newly perfected pen. Its refillable cartridge holds enough ink for many hours of smooth, uninterrupted lettering, thus eliminating the need for daily cleaning. The pen's cartridge is airtight—made of a non-porous, unbreakable, translucent material. The level of ink is always visible, and any non-solvent, waterproof India drawing ink can be used (for best results and quicker, easier filling we recommend the LEROY Lettering Ink-Cartridge #2950).

A tiny weighted needle inside the pen's feed tube assures a clear passage of ink from reservoir to point. Light vertical shaking of the pen activates this needle, removing any particles which may have settled in the tube when the pen was set aside. The needle also provides efficient cleansing action when you wash out the needle.

LEROY Reservoir Pens are furnished in seven sizes, from 00 to 5, for use with all LEROY scribers. Ideal for lettering work, the points glide easily over paper, cloth or film based surfaces, producing sharp, uniform lines that reproduce crisply.

Order Your LEROY Gatalog Now

Other new additions and improvements — too numerous to go into here — are described in the new LEROY catalog. The coupon below brings your copy, free.



just a beautifully simple idea, translated into products which reflect the highest manufacturing skill and imagination. Not easy, we grant you...but not magic.

However, to keep the LEROY line constantly up to the changing requirements of the times – that does require a wizard. Fortunately, we have just such a gentleman firmly settled on the K&E payroll. And he begs that we report several of the more recent minor miracles of LEROY right here and now. So, in the famed standard, sans-serif lettering template, let's make with a little . . .

abracadabra

Templates

Every year sees new additions made to the already long list of LEROY templates. Case in point: the new electronic tube symbol templates for use in one of the most modern, fastest changing industries of them all. Also, there are foreign language templates (such as Russian and Greek), music templates, special designs, and a variety of handsome type faces (Caslon, Cartographic, Bernhardt Modern to name some newer additions).

The best advice we can give for keeping current on LEROY templates is to have the LEROY catalog on hand. (It just so happens that we recently put out a brand new edition of the catalog, and it's yours for the asking. See coupon at right.) Finally, of course, we should add that if you don't see what you need in our catalog, don't despair. We'll produce it,

dulls — it's permanently sharp. And that, we submit, is a pretty sharp idea. The lead of this new pencil is an unvarying .020 inches in diameter, from one end to the other. All that's necessary to repoint is to advance the lead with a turn of the pencil



shaft. No need to remove it from the scriber, by the way. This new pencil fits all LEROY scribers, and guarantees faster, smoother work. As to appearance — all lines drawn with the "020" are perfectly

KEUFFEL & ESSER CO., Dept. MD-10, Heboken, N. J.

Please send me the latest catalog on LEROY Lettering Equipment by K&E.

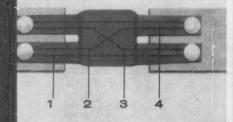
October	13.	1960	

Name & Title.

Company & Address_

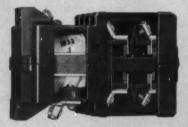


New contact reliability. Parallel bifurcated contacts, which allow four current paths instead of one, provide infinitely greater circuit reliability... liberally designed so any current path carries full relay rating.





At last! "Mechanical memory" latch as reliable as the relay itself! No adjustment ever needed. Add latch at any time. New simplified design! Cutaway view shows basic simplicity. Coil vacuum impregnated to resist damage from humidity, vibration, electrical stress. Terminals can be screw or spade type.





Space savingest relay you've ever seen: New Cutler-Hammer Compact 300"

Versatile 300 V. control relay is so reliable it's permanently sealed!

Here is the best answer yet to the need for an extremely reliable, small-size 300 V, 6 amp., industrial relay—the new "Compact 300" from Cutler-Hammer. Every detail known that affects relay

Every detail known that affects relay reliability has been improved in the "Compact 300." Bifurcated contacts which make possible *four* current paths rather than one, add millions of operations to the "Compact 300's" electrical reliability.

In fact, we're so confident of its electromechanical reliability, we permanently enclose the "Compact 300." And, if it should be damaged by a fault current, you throw it away and replace it with a new one. Its low price makes this an economical, practical maintenance procedure.

Now think of the space you can save with the "Compact 300." It controls up to

eight circuits in panel space only 2" wide by 2¾" high. 2, 3, 4, 6 and 8 poles with any combination of N.O. or N.C. contacts are available, of course.

At any time, you can add "mechanical memory" latch with a life equal to the life of the relay. No adjustments are ever necessary. Contact your Cutler-Hammer distributor for details on the "Compact 300" or send for Pub. ED-L079-U243.

What's new at Cutler-Hammer? New, better products, like the 300 V. relay are coming steadily from our new, expanded plant facilities. We're ready now to help you take care of the great industrial growth of the future. If you are planning ahead and need electrical control assistance, contact the nearest Cutler-Hammer sales office.

WHAT'S NEW? ASK ...

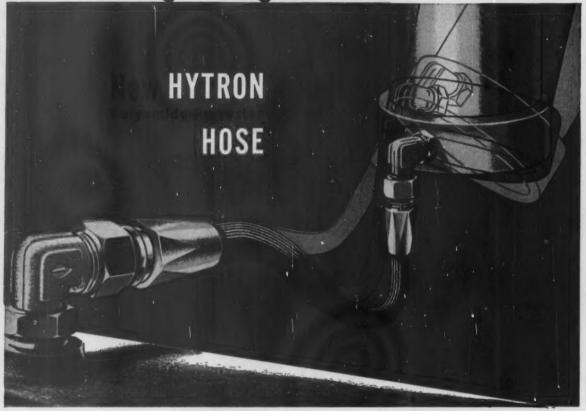
CUTLER-HAMMER

Cutter-Hammer Inc., Milwaukee, Wisconsin . Division: Airborne Instruments Laboratory . Subsidiary: Cutter





IMPERIAL Engineering and Data File



FAR GREATER FLEX-IMPULSE CAPACITY...

IMPROVED PRESSURE HOSE PERFORMANCE

Imperial unveils a completely new concept in pressure hose — opening new opportunities in hydraulic and pneumatic circuitry design, bringing new economies and advantages to thousands of other hose applications.

Hytron was created to solve many of the problems encountered in using S.A.E. types 100R1 and 100R5 hose. It radically reduces hose size and weight, offering smaller O.D. for equivalent pressure capacity and I.D.

Flex-Impulse Test Results

Hytron superiority under punishing flex-impulse conditions has been clearly demonstrated. Comparable 24" lengths of hose with couplings were subjected to cycles from 0 psi to 3500 psi at one-second intervals. Simultaneously they were flexed at 60 times per minute.

After 57.4 hours the S.A.E. 100R5 single wire braid rubber hose burst near a coupling. It took 415.5 hours —

over seven times as long — before the Hytron hose failed.



Note that there is no wire braid in Hytron hose. This eliminates one of the major causes of fatigue failure. Hytron is 80% lighter in weight, and, unlike wire braid rubber hose, retains virtually all of its flexibility under pressure.

Imperial Hytron hose operates in a burst pressure range from 9000 to 12,000 psi, depending on size and temperature. It is recommended for continuous service with fluids from -40 to 225°F, and for intermittent service to 250°F. Hytron is unaffected by nonflammable hydraulic fluids up to 180°F and flammable fluids up to 225°F.

Hytron hose is available in exceptionally long lengths. Furnished as factory-made assemblies, or with easy-to-install reusable couplings. Hytron couplings are of a new design that greatly minimizes flow restriction, offering up to 157% greater flow capacity.

IT'S IN THE BOOK

A new engineering report on Hytron hose and couplings contains detailed test results and performance figures. Send for your copy of Form No. NEPR-500 today.



THE IMPERIAL BRASS MANUFACTURING CO.

Dept. MD-100, 6300 West Howard Street Chicago 48, Illinois

NOW... Twin-Size

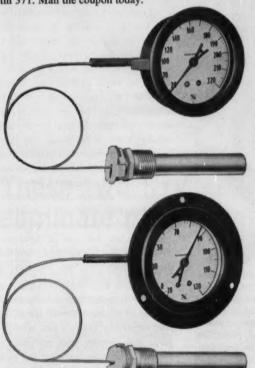
Pressure Gauges and Thermometers for "companion" installation

Appearance rates with high accuracy when gauges and thermometers are essential to the equipment you have "on the boards."

These size-matched pressure and temperature indicators are also similar in case, dial, and pointer design. Such "look alike" characteristics add a quality look to the design of any panel or other mounting surface.

Ashcroft Gauges and American Thermometers have a reputation for sustained accuracy and ruggedness in the most demanding power and processing industry services. Their fine quality is matched by long-term economy on all recommended applications.

Get complete technical data on these 2½" Ashcroft Gauges and American Thermometers, then select those best-suited to the equipment you are engineering. Write for Bulletin 371. Mail the coupon today.

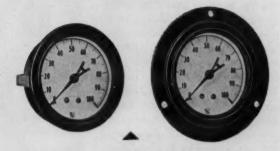


MANNING, MAXWELL & MOORE, INC.



Gauge and Instrument Division Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario



2%" ASHCROFT GAUGES

"U" Clamp and Front Flange Styles

Steel Case: 1/8" and 1/4" NPT centered back connection.

Ranges. Pressure: 0-15 psi to 0-600 psi. Vacuum: 0 to 30" mercury, or 0 to 34 ft. of water. Compound: 15 psi and 30" to 300 psi and 30".

Recommended Applications: For equipment such as portable compressors, pumps, water tanks, industrial washers, and pressure lines.

2%" AMERICAN THERMOMETERS

"U" Clamp and Front Flange Styles

Vapor pressure actuation. Steel case. Plain bulb; or cadmium-plated steel well for corrosion protection.

Ranges. Fahrenheit: Ranges from minus 40°/65° to 260°/450°. Centigrade: Ranges from 0°/100° to 90°/185°.

Recommended Applications: For air conditioning units, oil circulating systems, farm milk tanks, commercial frozen food cabinets, walk-in coolers, refrigeration lines.

Manning.	Maxwell & Mo	ore Inc	
	n Street, Stratfo		icut
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Title			
Company			
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LAMINATED PLASTICS What they are, where they can be used

Taylor laminated plastics, also known as reinforced plastics, are thermosetting-type materials formed by impregnating paper, cotton cloth, asbestos, glass cloth, nylon or other base materials with synthetic resins and fusing them into sheets, rods, tubes and special shapes under heat and pressure. These materials exhibit a valuable combination of characteristics, including high electrical insulation resistance, structural strength, strength-to-weight ratio, and resistance to chemical reaction; also adaptability to fabricating operations.

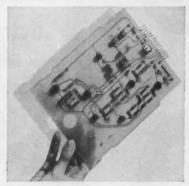
Types of laminated plastics made by Taylor There are four basic types of Taylor laminated plastics commonly specified and used throughout industry today. They are as follows:



Phonolic Laminates. Paper, cotton fabric or mat, asbestos, glass cloth or nylon bases impregnated with phenol formaldehyde resins. These provide strength and rigidity, dimensional stability, resistance to heat, chemical resistance, and good dielectric characteristics. Some Taylor grades are excellent basic materials for gears, cams, pinions, bearings and other mechanical applications. Others are widely used in terminal boards, switchgear, circuit breakers, switches, electrical appliances and motors. Also in radios, television equipment and other electronic devices; and in missiles as nose cones, exhaust nozzles, and combustion chamber liners.

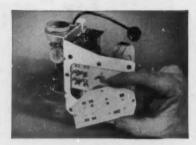


Melamine Laminates. Glass cloth or cotton fabric impregnated with melamine formaldehyde resin. Taylor melamine laminates have superior mechanical strength and are especially desirable for their arc-resistant qualities. Good flame and heat resistance, good resistance to the corrosive effects of alkalis and most other common solvents, besides other favorable characteristics. Typical applications include arc barriers, switchboard panels, and circuit-breaker parts in electrical installations.



Silicone Laminates. Continuous-filament woven glass fabric impregnated with a silicone resin. These laminates combine high heat resistance (up to 500°F. continuous) with excellent electrical and mechanical properties. They are primarily used in high-temperature electrical applications and high-frequency radio equipment.

Epoxy Laminates. Continuous-filament woven glass fabric or paper impregnated with epoxy resin. Glassfabric grades are designed for use in applications requiring high humidityresistance, good chemical resistance,



and strength retention at elevated temperatures. Paper grades are used under high-humidity conditions where resistance to acids and alkalis is required. Both grades are characterized by good dielectric strength, low dielectric losses, and high insulation resistance even following severe humidity conditions.

Recent technical advances in the bonding of various metallic and nonmetallic materials to laminated plastics have opened up new design opportunities. It is now possible to bond virtually any compatible material with a laminated plastic to form a composite which combines the advantages of both. One of the first composite materials was a copper-clad laminate used for printed circuits. More recent composite laminates, usually manufactured to customer specification, include the following: Taylorite® vulcanized fibre-clad, rubber-clad, asbestos-clad, aluminumclad, beryllium-copper-clad, stainlesssteel-clad, magnesium-clad, and silverand gold-clad. Any one of these materials can be sandwiched between sheets of laminates, too, and can be molded to fit specific requirements.

Send for complete information about any or all of these Taylor laminates. And remember Taylor's new selection guide will simplify your problems in choosing the right laminate for your specific application. Taylor Fibre Co., Norristown 47, Pa.





These two RIVNUTS® permitted redesign to eliminate parts; speed assembly

Here's why Hankscraft Company turned to B.F. Goodrich RIVNUTS when they streamlined design, production and appearance of the Model 200A Baby Bottle Sterilizer.

Before RIVNUTS, the electrodes and terminals were fastened to a large porcelain "dish" by screws and nuts. Four gaskets were required to prevent water leakage. A metal screw-on cap had to be fitted underneath the porcelain "dish".

RIVNUTS eliminate all these cumbersome pieces. Installed in the simplified plastic base, RIVNUTS secure terminals, provide water-tight nut plates. Two screws attach electrodes—and the unit is complete.

You can get B.F.Goodrich RIVNUTS in thread sizes 4-40 to ½"-13 with flat or countersunk heads. Rivnuts have hundreds of applications in appliances, electronic equipment, machinery and structures. Special types are available for aircraft and missiles.

Write now for free copy of Rivnut Design Data. Better yet, send us a sketch of your toughest fastening problem. Dept. MD-10, B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Akron, Ohio.

B.F. Goodrich Rivnuts

RATE STITOS VER

NEW! DUAL TORQUE-LOCKING AND POSITIONING DEVICE

REV-LOK eliminates feedback torque, provides two-directional positioning, drive, over-running and backstopping

NOW! You can have positive and instantaneous stopping of feedback (reverse) torque—it will never reach the driving equipment. For, the complement of sprags in this new Formsprag device is divided into two opposing sets that: instantly stops feedback from either direction, assures equalized radial loading, evenly distributes wear for longer life, and provides multi-contact surfaces for greater holding strength when high feedback torque occurs.

When the device is mounted with the outer race in a fixed position, feedback is stopped by wedging of sprags between output member and I.D. of fixed outer race—feedback never reaches the input shaft. Yet, this new design permits free rotation and transmission of high driving torque in either direction from input to output shaft. Current catalog models are available in ratings up to 30,000 lbs/in. and with bore diameters to 2%.

When used as a two-directional over-running clutch, output shaft member is mechanically secured against rotation and outer race then becomes the output member. A slight right or left rotation of input shaft disengages either set of sprags and determines direction of drive, over-running and backstopping.

This versatile device can also be used for two-speed drive and reversing applications. By connecting a low-speed reversible motor to outer race and a high-speed motor to input shaft member, driving torque can be transmitted at two speeds or reversed.

Smallest standard Rev-Lok sizes (%" and ¼" shaft diameters, 96 lbs/in. output and holding capacity) have the following additional features: mounting flange on outer race, end-to-end or coaxial drive, completely enclosed and permanently lubricated, economical sleeve bearings and roller type contacts.

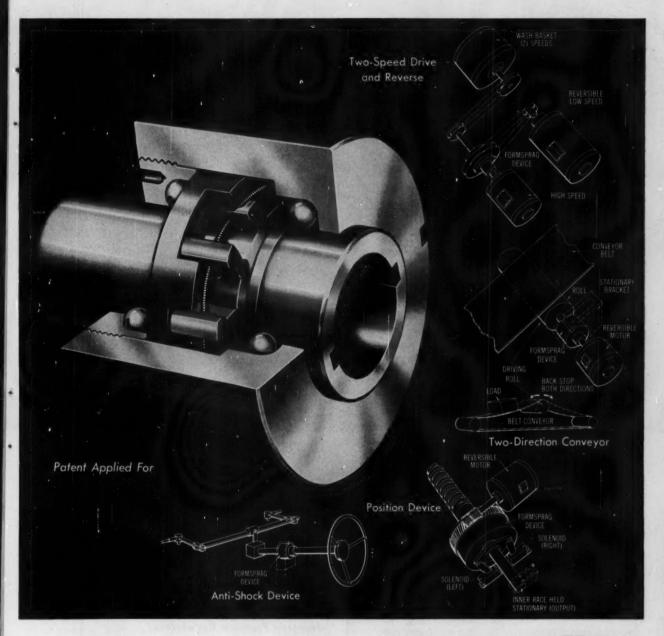
Rev-Lok devices not only drive, position, over-run and backstop in two directions, but they also provide automatic, instantaneous and positive prevention of feedback from driven equipment to power source. They are compact, have greater torque capacity for their size and weight and permit higher over-running speeds than any similar device. Formsprag technical paper provides further details on operation and features, send for your free copy.

FORMSPRAG COMPANY, 23603 Hoover Road, Dept. 105R, Warren (Detroit), Michigan Distributors in Principal Cities.

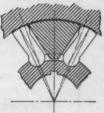


ORMSPRAG COMPANY

Precision Power Transmission Products



BECAUSE there is a complement of sprags arranged in opposing pairs, there is always a multiple number of contact surfaces engaging the outer race when feedback or backstopping conditions are present. This provides equalized radial loading and strong holding torque against even unusually heavy feedback.



The entire complement of sprags, which is a part of the output member assembly, rotates at driving speed while outer race remains stationary. Thus, sprags are in light contact with the outer race and are always in position to pick up the feedback load at constantly changing points on the outer race. This design feature assures longer life through even distribution of wear over entire surface of outer race. With sprags in constant contact with outer race, any independent movement of output shaft causes instantaneous locking of sprags—there is no backlash on output shaft.

RAWSON Centrifugal Clutches

No-Load Motor Starts, Cushioned Starting of High-Inertia Loads, Overload Protection.



OTHER FORMSPRAG PRODUCTS

FORMSPRAG Over-Running Clutches

For Every Over-Running, Indexing & Backstopping Application



All Pressure Regulators are not alike



Baffle and Siphon Tube-Construction

provides more uniform regulated pressure as flow demand changes

In the ideal pressure regulator there would be no change in the regulated pressure no matter how wide the variations in the flow rate.

Norgren Pressure Regulators approach this ideal by providing a baffle and siphon tube feature. This increases the sensitivity of the valve to changes in the flow rate through the regulator and provides better performance and a more uniform regulated pressure over a wide range of flow rates.

The baffle protects the diaphragm from pressure shock and abrasive action. This gives you longer regulator life, more dependable operation and minimum maintenance.

For complete information on all your regulator needs, 1/8" to 2", call your nearby Norgren Representative listed in your telephone directory-or WRITE FACTORY FOR DESCRIPTIVE LITERATURE.

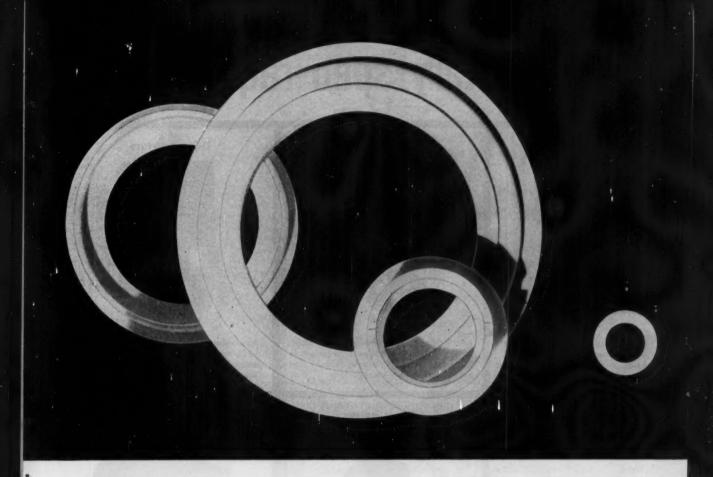
Norgren Pressure Regulators give you these important features:

- Balanced Valve Construction improved regulator performance
- Large Nylon-reinforced Buna N Synthetic Rubber Diaphragm — long service life
- Baffle Plate and Siphon Tube increased accuracy
- Large Passages and Valve Openings—large flow capacity
- · Easy servicing while still on air line
- Flexible Valve Pin-assures better seating

FOUNDED IN 1926

C. A. NORGREN CO.

3442 SOUTH ELATI STREET . ENGLEWOOD, COLORADO



Corrosion and Abrasion Resistant Coors Ceramics Provide Long, Maintenance-Free Service Life

Mechanical shaft seal rings of Coors Alumina Ceramics give extended service life under severe operating conditions.

Under abrasive conditions, seal faces maintain their surface finish. The extreme hardness and toughness of Coors Alumina Ceramics provide maximum resistance to abrasion.

In corrosive applications, seal faces will not pit or corrode, because Coors Alumina Ceramics are chemically inert to almost all fluids.

Coors Ceramic shaft seal faces are lapped flat-and they stay flat. The ceramic will not warp or distort under mechanical strain or heat

In production runs, Coors laps seal faces to a flatness of less than

3 light bands in sizes up to 3" O.D. Extremely fine surface finishes can be obtained by lapping and surface polishing. Regular production includes sizes up to 15" O.D.

Seal rings of Coors Alumina Ceramics are frequently used in abrasive or corrosive applications; or applications where maximum dependability is required, such as aircraft and nuclear environments. However, they are also found in applications where price is a factor, as in tractor water pumps, submersible water pumps, and household appliances, including dish washers. disposers and washing machines.

Mechanical shaft seal units with Coors Alumina Ceramic parts are available only through seal manufacturers. We will be glad to furnish you with names of these customers. For materials application, we stand ready to work with you in utilizing the unique properties of Coors Alumina Ceramicsprototype or production runs. Contact the Coors regional sales manager nearest you, or write for complete data.

REGIONAL SALES MANAGERS
West Coast
MidwestJohn E. Marozeck FR 2-7100-Chicago, Ili
GL 4-9638—Canton, Ohio
East CoastJohn J. McManus MA 7-3996-Manhasset, N. Y.
New EnglandWarren G. McDonald FR 4-0663-Schenectady, N. Y.
Southwest
Oil Field IndustryWilliam H. Ramsey UN 4-6369-Houston, Texas

Circle 479 on Page 19

Soots Alumina Ceramics

Meet military spec requirements

AC contactors



For magnetic operation on motor loads through 200 hp at 440 volts, 3-phase, 60-cycle; are available with 3 or 41/2 poles.

AC relays



Interlocking or undervoltage relays; available with four to eight poles in ratings to 10 amps; both single-pole (above) and multi-pole contact arrangement.

DC contactors



Diesel-starting (above), time-delay, sizes 1, 2, and 3 for magnetic operation on motor loads through 25 hp at 230 v d-c. Submarine service forms available.

Thermal overload relays



Both heater- (above) and induction-type; adjustable from 90 to 110 percent of rating; resetting time 60 seconds after tripping. Reset relays



A remote method for resetting overload relays; consist of potted solenoid coil and a mechanical linkage on corrosionresistant steel base with insulated leads. Panel-mounted pushbuttons



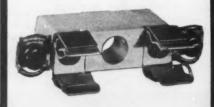
For use on a-c or d-c circuits where momentary contact is required; available in standard or oiltight forms in variety of contact arrangements.

Terminal boards

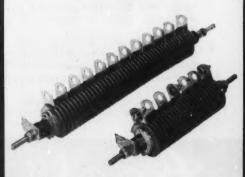


Designed for 25-, 50-, 100-, and 150-amp circuits. Termination points—either 2, 3, 5, 7, or 9—have fire-resistant base.

Fuse blocks



Rated up to 30 amps; blocks consist of a fire-resistant molded-compound base with metal terminals and fuse clips; convenient single-hole mounting. Resistors



Starting and regulating duty on motor and generator field adjustment, load banks, etc.; available in ratings from 21.5 to 42.5 amps continuous and five lengths.

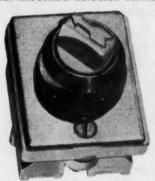
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DC relays



Multi-current and overcurrent (above) are used as interlocking or undervoltage relays, and on electronic applications requiring shock-damage design.

Panel-mounted selector switches



For use on either a-c or d-c circuits where maintained contact is required; available in three forms; can be mounted on panels up to 3/16-inch thick.

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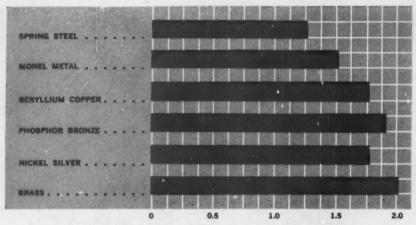
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How <u>Temperature</u> affects spring stiffness

When service or operating temperatures are above room temperature, spring selection must take into consideration several factors usually of little consequence in ordinary service.

These are loss of strength, thermal expansion, deflection, drift and hysteresis.

The first effect — loss of strength — is usually the most serious. What happens is that the safe stress carrying capacity of the spring material decreases at higher service temperatures and springs of ample strength at room temperature may be too highly stressed when heated.

These effects may be small in many cases, but under some conditions they may be important, particularly when temperatures vary over a wide range. Where an accurately determined spring strength at elevated temperature is desired, the specifications covering load test at room temperature should be corrected for the change that will occur. The approximate amount of correction for 100° F change in temperature for various materials is shown in the chart above.

With today's increasing high-temperature problems in many fields, proper spring selection is more than ever important. The subject is discussed in our latest pamphlet, "High Temperature Springs." Write for your copy.





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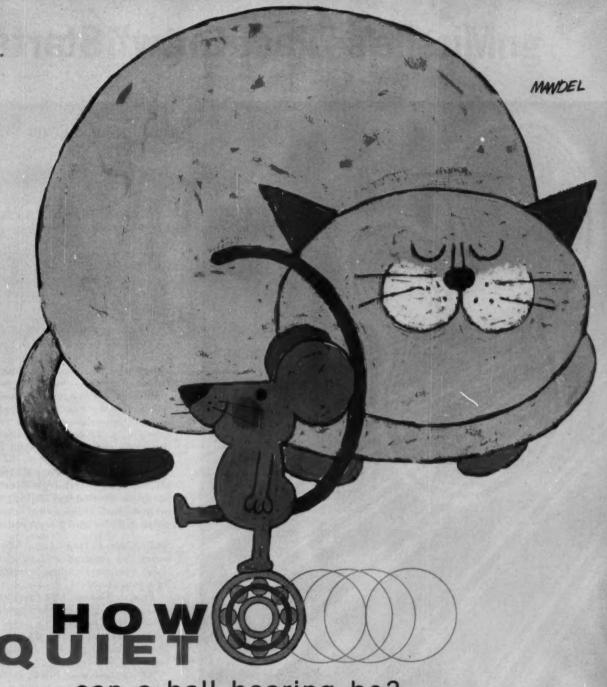
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Missile's "Fast Draw" Starts



Cold-drawn Seamless Cuts Clean-up Costs For Anker-Holth's Power Cylinders

The Missile Age version of the "fast draw" starts with the lightning stroke of a power cylinder.

Big, 12-foot stroke hydraulic cylinders provide the power and speed that unsheath one of the nation's principal defense missiles for instantaneous action.

They're made by Anker-Holth Division of The Wellman Engineering Company from Pittsburgh Steel Company's commercial quality, carbon steel, Seamless Mechanical Tubing.

Mounted two to a unit, the husky cylinders must—within seconds, and without fail—slide back the two halves of the hangar-size missile shelter to release the weapon for firing.

Anker-Holth, of Port Huron, Mich., uses Pittsburgh Steel's Seamless Mechanical Tubing to manufacture this critical unit's outer cylinder and piston rod.

Relies on Pittsburgh—What makes this company rely on Pittsburgh Steel for the tubing it requires for this application?

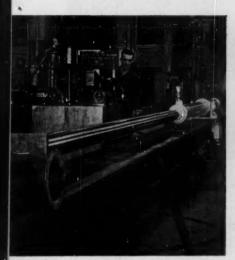
Fred J. Theisen, vice presidentproduction, says there are several reasons. He explains:

"First is Pittsburgh Steel's service. They're able to give us information fast.

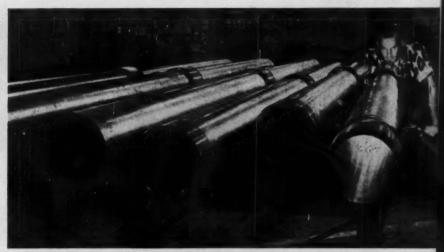
"On the first lot of tubing for this job, we asked all our suppliers for recommended sizes for cleanup to our finished dimensions. Pittsburgh

Piston rod made by Anker-Holth for launcher shelter's roof activating cylinder requires only minimum processing for cleanup with commercial quality Pittsburgh Steel Seamless Mechanical Tubing. Finished rods, 142" long, are plated with hard chrome. Vice president-Production Fred J. Theisen, (left) talking with Pittsburgh Steel salesman T. J. Whan, says Anker-Holth relies on Pittsburgh Steel tubing for this missile component.

With Pittsburgh Steel's Tubing



Final hydraulic testing on completed cylinders is comprised of 30 cycles at 4,500 psi-using special Anker-Holth testing equipment.



Fast service, straightness, and minimum stock removal convinced Anker-Holth that "Pittsburgh was best we could get for this job." Cylinder measures 5 inches by 4 inches by 143 inches. Anker-Holth specializes in power cylinders with bores from one to 48 inches, and strokes to 45 feet.

Steel's answer was in first, and it suggested less stock removal.

"That's important, and it's one reason Pittsburgh Steel stays with us. We ask them for size recommendations that we need for cleanup. They tell us the size, and they do it in a hurry. They don't wait around for a couple of months to reply.

"For another thing, when we first started production of this cylinder, we had a problem of straightness.

"I don't know how they did it, but Pittsburgh Steel came through with a batch of tubing I had never seen the equal of. Pittsburgh makes a quality tube. Straightness is the big thing-plus service and the amount of stock we must remove. With Pittsburgh Steel Seamless Tubes we don't need extra metal for honing-so we aren't paying for metal we don't use."

Experience Pays-Close attention to customers' needs and experience, plus steelmaking skills and production practices developed in nearly 50 years of seamless tube production, make Pittsburgh Steel able to serve Anker-Holth this way.

In this instance, Pittsburgh Steel's ability to produce commercial quality cold-drawn seamless mechanical tubing to exacting standards for straightness, concentricity and tolerances, allows Anker-Holth to simplify its cleanup process of the cylinder's ID and centerless grinding of the piston

Machinability and weldability of Pittsburgh Steel's tubing are vital factors in Anker-Holth's production, too, because plugs, ports, sleeves, piston and end covers are threaded

and/or welded to the piston rod and cylinder in this application.

Contact one of the distributors or district sales offices listed below. Then let Pittsburgh Steel Company demonstrate its ability and readiness to help. You, too, will find that Pittsburgh Steel's tubing is the best you can get.

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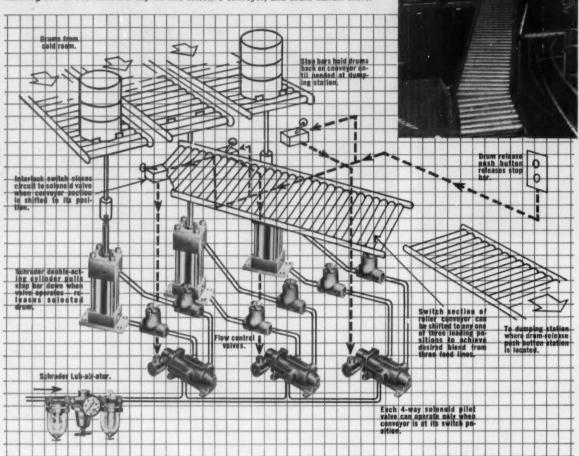
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Circle 483 on Page 19

Processors automate even heavy work with air. In a complex frozen juice concentrate blending operation, Plymouth Citrus Products Cooperative, Plymouth, Fla., hooks up Schrader Air Products simply and economically to a gravity conveyor. Full 55-gal. barrels on feed sections roll down to stop bars and are selected in correct order and ratio for dumping. "The Schrader system performs well," says C. Byron Smith, plant manager. "We're handling 200 to 300 barrels a day on this selective conveyer, and could handle more."



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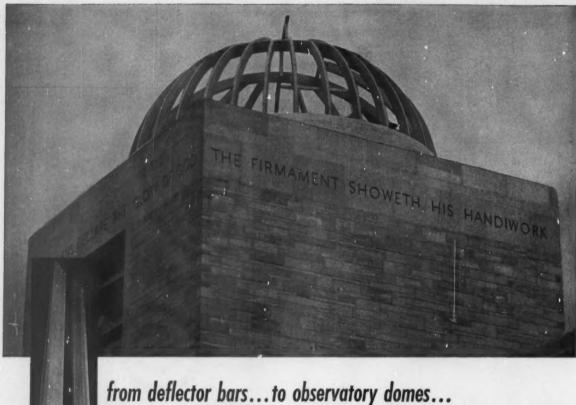
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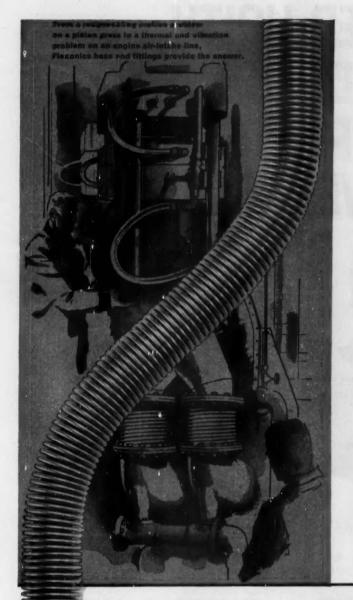






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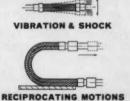
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Fittings Design Guide, covering in detail Flexonics products and services.

ANKER-HOLTH CYLINDERS FULFILL RIGID WESTINGHOUSE



A new gearless "Flying Press", especially designed and built by Wean Equipment Corporation for Westinghouse Electric Corporation's Standard Control Division at Beaver, Pa., is equipped with Anker-Holth cylinders.

The press operates at twice the production rate of the presses previously used for this operation. It offers reduced die maintenance and permits simplified over-all machine maintenance.

Necessary components in the press are rugged, reliable cylinders for pulling the lower bed out of alignment in event of cobble or mis-feed emergencies. Wean has found that Anker-Holth cylinders fulfill this rigid and exacting requirement.

Chances are, Anker-Holth has the answer to your power cylinder needs, too. You may choose from the world's widest selection of standard models, available in all mountings. Special cylinders can be designed to your exact requirements, usually assembled from a combination of standard parts.

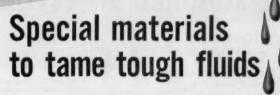
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DESIGN

October 13, 1960



Increasing Your Gain

HAT is the basic purpose of design engineering? In the last analysis, isn't the objective to help multiply man's effectiveness in coping with his environment?

The original design engineer's first product was probably a club that amplified the effectiveness of his bare hands.

The rest of mankind adopted the tools and weapons of the design engineer. Then political and social systems developed with the purpose of further multiplying man's effectiveness.

Today's design engineer finds himself enmeshed in one of these social systems—his company. The measure of his effectiveness is no longer the length of his club, but his ability to get things done, within that framework. It is a sad fact that too many members of the world's second oldest profession—design engineering are not nearly as effective in coping with their environment as were their predecessors who first clubbed a dinosaur.

The frustrations of present-day engineers are neatly pinpointed in the first paragraph of Phil Marvin's article in this issue. Dr. Marvin then goes on to spell out the techniques for multiplying an engineer's effectiveness.

His article is, so to speak, a blueprint for an amplifier to increase your "gain." Keep the signal-tonoise ratio high and the distortion low—and good luck!

bolin barmilael

How to

Multiply Your Effectiveness

as an Engineer

PHILIP MARVIN

Division Manager Research and Development American Management Association New York, N. Y.



TWO tragic conditions exist in almost every company which employs engineers. On the one hand, there are engineers who want to do a better job—who want to multiply their effectiveness—but don't know how to go about it. On the other hand are engineers who are satisfied just to get by.

These two situations are costly both to the individual engineer and to his company. They are particularly unfortunate because, to a large degree, they can be avoided. If individuals would give the same time and attention to making effective use of their talents that they give to acquiring and developing these resources, they could multiply their effectiveness many times. The mantle of success seldom falls over anyone's shoulders. It is achieved by hard work. But effort alone is not what counts; it's effective effort that is important.

Executives who manage engineers say, "Experience hasn't taught him anything," in referring to an engineer who isn't making the grade. This expression is not limited to what the engineer experiences personally. He should also learn from the experience of others.

Not every engineer is exposed to the same opportunities to learn from experience, but an even greater number fail to profit from opportunities that are open to them. Almost a century ago, Dr. Russell H. Conwell delivered his famous "Acres of Diamonds" address. He pointed out that the obvious is overlooked too often, and that there are acres of opportunities close at hand.

Beyond certain limits one can't work any harder. But, successful engineers have the ability to multiply their effectiveness. In doing this, certain checkpoints serve as guides. They focus attention on the individEffective action is easy. It calls for the least effort and time. It is direct and to-the-point. Unfortunately, it isn't the way most people have learned to act.

The reason for an individual's relatively ineffective action patterns is that the patterns have developed in a haphazard manner. No particular thought was given to this development. Now the patterns are habits, and habits are hard to break.

By nature, individuals tend towards deviousness. Problems are approached from the rear. Action is substituted for analysis. Minor problems are attacked before major ones.

Periodically, it pays to stop and re-examine action patterns. The important question is "Am I putting first things first?" Effective action isn't the difficult way of doing things; it's the easy way. It isn't the long way around; it's the shortcut. It doesn't involve a lot of detail; it is ruthless in eliminating distractions.

The test of effective action is this: Has the desired result been achieved with the least effort in the shortest time? Effective action is compromised by anything short of a combination of desired results with the least effort in the shortest time.

ual engineer and the assignment in which he is engaged. They center on things engineers can do now.

Are personal goals established?

Success is given as a goal by some people, but this is meaningless unless one spells out what he means by success. Money, say others, but this too is incomplete unless accompanied by an indication of the price one is willing to pay for money. One of the first things really successful people have learned to do is to measure success by their own standards rather than those of their associates.

Engineers' goals must pass the test of practicality in the light of existing conditions. Goals should be written down so that they can be examined objectively. Several questions can be asked to test the practicality of goals: What steps must be taken to achieve these goals?

Are the implied sacrifices recognized and acceptable?

Are required resources available?

Is a satisfactory timetable developed?

Of course, goals must be clearly delineated and reasonably attainable. When dreams are substituted for goals, frustration results.

Each engineer must establish goals in terms that are personally acceptable to him. He, alone, must make the effort. He, alone, must live with the results. Engineers work most effectively after they have established goals which are worthwhile to them.

Do goals fit company plans?

This second checkpoint takes on meaning only after developing individually acceptable plans. This

done, the second checkpoint prompts examination of the degree to which personal plans are aligned with company plans.

Few engineers are in a position to change company plans. Yet each engineer works most effectively when his personal plans fit in with those of his company. An engineer can't work productively when his attitude toward his job and his company is negative. One of the best bits of advice passed out from time to time is this—work for the company that employs you.

After making a critical appraisal of company programs, and comparing them with personal plans, an engineer should be in a position to decide whether or not he is apt to achieve his goals in his present company.

Before writing off a present position, it is prudent to make certain that more favorable circumstances actually exist elsewhere. It is easy to develop a set of personal plans which don't fit those of any com-

Frustrated in an attempt to accomplish an objective, an engineer remarked, "I'm not stupid. I went to college. What's wrong?" The thing that is wrong in many cases is the individual's failure to apply what has been learned. Education provides the knowledge and skills—but these are useless unless they are effectively employed.

Are performance levels adequate?

Once goals and opportunities are sharply aligned, personal effectiveness is limited only by capacity to perform. Ten checkpoints aid in developing individual capacity to perform:

1. Drive

Achievement of maximum results with a minimum of effort calls for the driving force of a self-starter and the ability to follow jobs through to their completion. When an engineer depends on someone else to take the initiative in either starting or finishing his assignments, he is not using his full potential.

Most engineering assignments are part of a process in which work passes from phase to phase. But, insofar as possible, engineers should exercise



Self-start and follow-through cuts a two-man job to one.

initiative in generating plans and executing them. These abilities are important in any assignment. Few jobs have a simple beginning or a clear-cut ending. In many cases only the engineer responsible for the assignment is in a position to determine when his job is finished and how well it has been executed.

Those who want to increase their effectiveness should make certain that new programs are started when needed. Many times, the engineer alone can sense these needs. When he lets these opportunities escape, the work he does perform is less valuable to his company. Others ultimately seize unexploited opportunities.

When the engineer lacks sensitivity to detail in following assigned work from start to finish, the results reflect loss of both thoroughness and speed of execution. Failure in either respect is costly to the individual and to his company.

Self-starters are frequently puzzled by an apparent lack of recognition given to their ability to generate new programs. A good record at the starting line, but a poor record at the finish line may be the reason. Profits are reflected in completed assignments. Engineers can profitably examine their records in this respect.

2. Responsibility

A sense of responsibility is essential to effective action. Engineers who lack a sense of responsibility do not have the confidence of either those they work for or with. This condition seriously weakens their ability to work effectively. An engineer may be made responsible for a particular undertaking, but unless he can discharge this responsibility it is taken away.

To engineers, the concept of responsibility has three dimensions.

First, it implies a willingness to personally guarantee that a certain result will be delivered on time. The product of engineering effort is information and prototypes which can't always be delivered as soon as desired. In his professional capacity, the engineer must weigh time and cost along with limitations of the technology involved in estimating time factors. The final guarantee should be one he accepts willingly and to the best of his ability. This does not imply that he should permit himself to be stampeded into a commitment against his best judgment.

The second dimension of responsibility is quality. Performance must be timely, and it must satisfy all other requirements of the assignment. A professional assignment is easy to distinguish from a nonprofessional job. In the case of the latter, performance can be evaluated by those without special training. In most engineering assignments, only the engineer in charge is in a position to know whether or not an assignment has been satisfactorily executed.

To act effectively, an engineer must establish and

maintain a reputation for quality. He must know the technical limitations on the quality of the end result of his work. He must make these limitations clear to others in order that they may make the most effective use of engineering output.

The third dimension of responsibility is quantity. An engineer's output must satisfy this third criterion.

No one can act effectively who will not accept responsibility. Engineers who have not demonstrated this ability to accept responsibility are not given the opportunity to multiply their effectiveness because of the uncertainty and unreliability of their output.

3. Analytical Ability

The ability to size up a situation is basic to effective action. Time and effort are both wasted when action is taken on the basis of an incorrect analysis of problems to be solved. Naturally, ambitious engineers want to "get on the ball and keep it rolling." Analyzing the problem doesn't kick up as much dust and isn't as dramatic. Consequently, it is slighted.

But when the ball stops rolling and the dust dies down, results are what count. Action, to be effective, should be taken only after carefully sizing up a situation and determining the best course to follow. Often the apparent problem isn't the real problem. One of the great contributors to ineffective action is misdirected effort. Careful observation alone reveals real trouble spots—problem areas that may otherwise be buried in a flurry of activity.

Having highlighted fundamental problem areas, engineers can apply their time and effort to the development of all of the facts pertinent to the problem. These facts are the basis for decision-making and action.

4. Creative Capacity

An individual's creative capacity establishes limits or creates horizons for specific undertakings. While creativity can be developed to a degree, the change is rarely dramatic. More often, untapped creative powers are uncovered. When creative capacities are evaluated, talents can be matched to assignments.

Certain assignments call for highly creative talents. In these situations, any action attempted by an engineer who lacks highly creative abilities will be largely ineffective and pedestrian in character.

Any assignment, however, provides opportunities for innovation. Every engineer, to the limit of his ability, should introduce new and better ways of doing things. In so doing, he is multiplying his effectiveness.

One of the greatest barriers to the use of creative capacities is the failure to recognize the tremendous opportunities for improving effectiveness by breaking away from traditional patterns of action and thinking. These opportunities are open to every engineer re-



. . . creative capacity establishes . . . horizons . . .

gardless of his inherent creative capacities. The payoff from creativity has never been related to the degree of creativity involved. Multiplying effectiveness is not so much a matter of relative creative capacity as the use to which this is put by the individual.

5. Foresight

One must recognize opportunities. Effective action is based as much on foresight as effort, Good hard work channeled in the direction of outstanding opportunities is much more rewarding than the same amount of effort applied where opportunities are scarce.

The ability to sense opportunities that appear on the horizon is particularly important in engineering today. Technology is making rapid advances that reveal a great many opportunities for the individual engineer to seize. Yet, how many engineers continue to perform their daily assignments without setting aside time to explore opportunities?

Some years ago, someone combined the word imagination with engineering and came up with "imagineering." It's a picture-word that directs attention to the need to stretch the thinking process beyond the realm of reality. Here lie the great opportunities. The results from efforts applied selectively can be tremendously more rewarding than when effort is applied to routine ends.

Worthwhile advances in any undertaking have resulted from recognition of opportunities and action based on this foresight. As an individual assumes greater responsibilities in an organization, his ability to see ahead becomes increasingly important. In exercising foresight, the engineer must examine all available facts at his disposal, and anticipate new ways this information might be applied.

6. Communicative Skills

One of the important steps in multiplying individual effectiveness is through the use of highly developed communicative skills. A genius can't be differentiated from a mediocre engineer unless he has the ability to express himself. Many truly great ideas have lain dormant in the minds of engineers because they weren't communicated properly.



Ability to communicate . . . unlocks a door . . .

The engineer's most important product is information. But this information is useless unless communicated to those who can use it. One of the best ways to increase one's effectiveness is to improve the channels in which this information flows.

Communication is more than choice of words, tone of voice, and style of writing. Such factors as time and place of delivery are equally important.

It is a tragic fact that at so many critical points, where every opportunity for a free flow of ideas exists, engineers either fail to recognize the need or are unwilling to devote the time and attention to the development of communicative skills.

7. Technical Proficiency

Probably more time and attention is devoted to the development of technical abilities than to all of the other equally important performance checkpoints. This is the most significant reason why the performance of so many engineers falls so far short of the goal.

By analogy, the development of a commercial jet airplane illustrates the point. The engineering achievement represented by this plane would have been worthless unless the other parts of the system into which it fitted had been given equal attention. The fastest plane in the world has little significance as a commercial vehicle if it serves airports so close that it can never achieve optimum cruising speed and altitude.

Technical proficiency is essential. One can never be too proficient providing performance in all other respects is balanced. Development of technical proficiency at the sacrifice of other important performance factors results in effectiveness. Unquestionably, some compensation takes place.

But when individual performance falls off, there is a tendency to seek protection behind barriers of technical proficiency. Nothing is more disastrous, because the false sense of security closes the mind to other points of vulnerability.

Technical proficiency is an absolute essential. The common mistake is to regard it as the only absolute

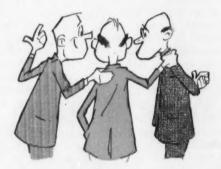
essential. Recognizing this, many engineers whose technical proficiency is below par have been able to rise above their colleagues. Their secret—the achievement of maximum results with minimum resources by balancing talents and skills.

8. Sociability

Current literature observes that the managerial revolution has all but eliminated opportunities for the lone wolf. This is nowhere more true than in the engineering profession, Modern technology has created conditions that magnify the importance of team activity.

An engineer must be socially acceptable, but not in the narrow and superficial provincial caste-system sense. Personal effectiveness depends on being the type of individual whose presence makes a real contribution to any group.

Small things count, It's not so much what is done but how it's done. The effective engineer doesn't



Sociability . . . important ingredient of . . . action . . .

call attention to himself through his actions. He commands attention through results.

Sociability must be recognized as one of the most important ingredients of effective action. It is even more important to understand what is meant by sociability. The man who is always badgering his associates to "go out on the town" is more apt to be thought of as a bore than a social asset. The best test is the degree to which the individual is sought out by others because his presence has a catalytic effect in making almost any occasion more pleasant by his presence.

9. Resourcefulness

Engineers have always been given the responsibility for making effective use of available material and energy resources, but they don't always apply themselves to the job of making effective use of personal resources.

Each engineer has varying degrees of certain specific resources. These resources include talents,

money, time, and available markets. He should recognize them both qualitatively and quantitatively and then put them to use.

The most common failing of candidates for top positions is the inability to know how to fit the pieces of their careers together into something saleable. Some candidates seem to think that all they have to do is to dump the parts of their careers down on an executive's desk, and he would piece them together and decide what could be done with them. Nothing, of course, is farther from the truth.

Engineers who want to act effectively should apply every resource at their disposal to the best possible end use. Resources should be noted and evaluated. The strongest combination of resources should be established and the best use for this combination determined. If present assignments don't make full use of these resources, an effort should be made to modify the existing situation. When this has been tried without success, a change of location may be indicated.

Several questions can be asked in making a personal appraisal:

Do I know what my resources are?

Am I exhausting every opportunity to use them in my present assignment?

What resources aren't being used?

Answers to these questions can be quite revealing. Few engineers use more than a fraction of the total resources at their disposal. Opportunities surround these engineers, but they don't capitalize on them.

10. Judgment

Few matters can be judged as right or wrong, or in any other clear-cut manner at the time decisions must be made. With less than complete information, decision-making must still take place.

Judgment is based in part on perceptiveness-



Engineers must . . . weigh every act . . .

the ability to sense the really significant aspects of a problem. Almost any problem has certain critical elements. Strike at these to save time and energy.

Objectivity is an equally important element in judgment. It is not the means to the end that is important, it is the end in itself. It isn't problem solv-

ing that is important, it is the effect of the solution. Sound judgment can only be measured in terms of results. Engineers must always keep in mind the things they are trying to accomplish and weigh every act in terms of speeding achievement of these goals.

Experience is important too. It combines background, perspective, and practice. Sound judgment calls for all three. Everyone makes mistakes, and engineers should learn from each one.

Having the courage to act is one of the basic characteristics of good decision making. Too many times, opportunities have been missed by inaction. Rarely does anyone have all of the facts at his disposal in decision making. There is a point beyond which time lost in waiting for more data on which to base decisions costs more than it is worth.

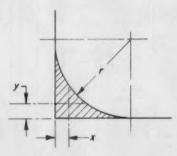
Bernard Baruch has said it this way: "There are some problems on whose solution we must wait for the workings of time. But with many other problems, inaction is the worst possible course."

Tips and Techniques

C. G. of Fillet

The center of gravity of a 90 deg spandrel or fillet is given by

 $x = y = 0.2146 \, r^2$



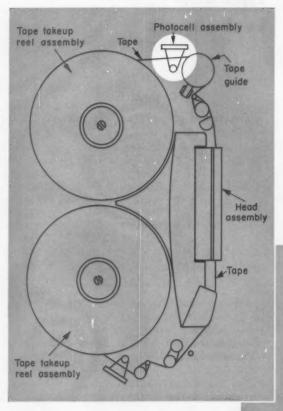
where r is the fillet radius as shown in the figure.

—RAYMOND MOORE, Albany, N. Y.

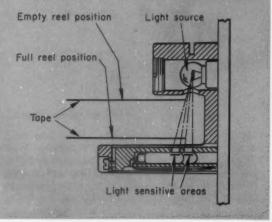
Cold Heading

In Fig. 3 of the article, "Cold Heading," August 18, 1960, the dimension 0.087 should be 0.187.

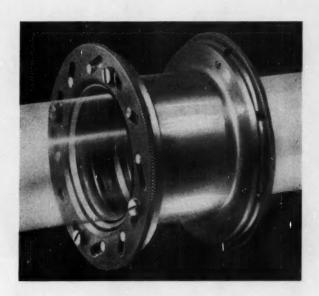
scanning the field for ideas



Tape-shaded photocell varies torque on data recording tape to maintain constant reel tension with changing tape-pack diameter. The pack diameter sensing unit is located between the reel and the first tape guide. The light reaching the photocell is interrupted in different proportions as the tape-pack diameter varies from full to empty reel. This is accomplished by placing the light source below the tape edge and the photocell above and on the opposite side of the tape. Principle reported by Robert Peyton as employed in data recorder developed by Ampex Corp., Redwood City, Calif.



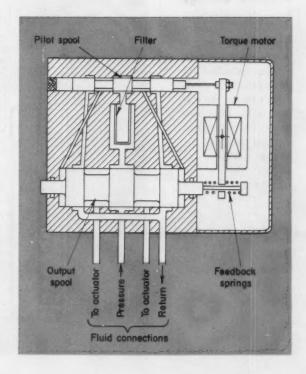
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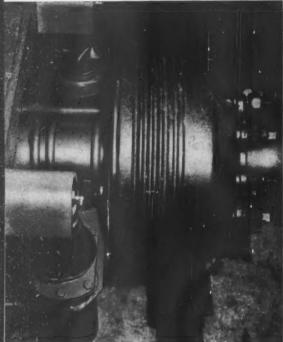


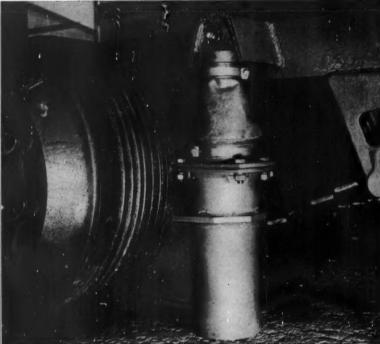
lris-type lock ring clamps coupling for lightweight pipe. Hand torque, applied to ring, moves pins inward, and clamps coupling to the pipe. Principle employed in lock ring developed by National Utilities Corp., Monrovia, Calif.

Dithered pilot spool of electrohydraulic servo valve reduces static friction to provide response to small control signals. A dither of 0.5 w at 400 cps permits full flow to be obtained with signal power as low as 2 milliwatts. Principle employed in servo valve developed by Consolidated Controls Corp., Inglewood, Calif.

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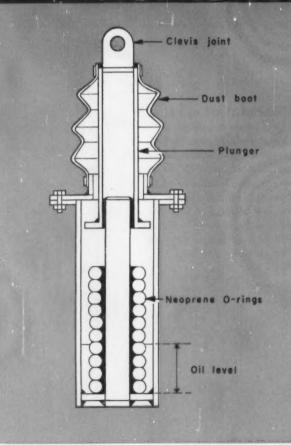






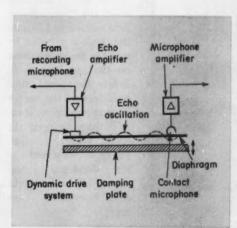
Stacked O-rings

form shock-absorbing element of auxiliary suspension system. A frame - supporting plunger, attached to the vehicle by a clevis joint, rides on the column of Du Pont neoprene O-rings when the load depresses the plunger sufficiently to contact them. An alignment rod holds the O-rings in position. Principle employed in shock absorber developed by Western Unit Corp., City of Industry, Calif.



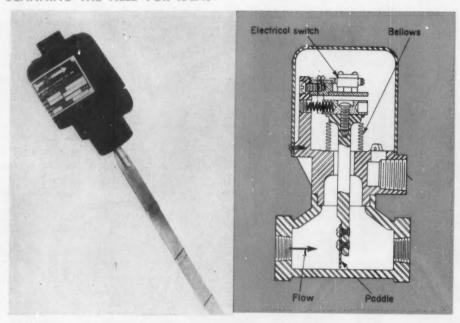


Spring-loaded assembly eliminates end play by preloading a micrometer spindle in the direction of gaging load application. The lower portion of the nut assembly which engages the spindle thread is fastened to the micrometer sleeve. The upper portion of the nut engages the threads of the spindle. The mating faces of the assembly are serrated to prevent rotation of the upper portion of the unit assembly. Principle employed in micrometer developed by J. T. Slocumb Co., South Glastonbury, Conn.

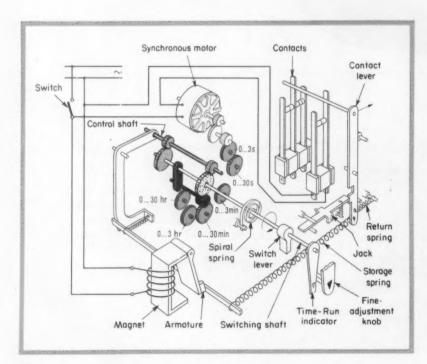


King-size diaphragm serves as both loudspeaker and microphone in an echo machine. The input signal drives the 3 x 7 ft, 0.02-in. thick diaphragm as a speaker at one end. At the opposite end, a contact microphone picks up the delayed vibration for reamplification as an echo. Principle employed in an echo machine developed by Wilhelm Franz KG, Lahr/Schwarzwald, Germany.

SCANNING THE FIELD FOR IDEAS



Bellows-supported paddle senses flow to operate a control circuit. Deflection of the paddle by flow in the line operates a linkage to actuate a miniature electrical switch. Principle employed in a flow-actuated switch developed by Power Engineering and Equipment Co. Inc., Torrance, Calif.



Shift-gear timer

uses output from any one of six gears to provide desired timed interval. A solenoid provides the force to engage the selector gear and thus permit the operator to manually select the range desired. Fine adjustment within the range is provided by rotating the switch lever on the switching shaft. When the preset time has elapsed, the switch lever trips a spring-loaded linkage to open the circuit being controlled. Principle employed in timer developed by Siemens - Schuckertwerke AG, Nuremburg, Germany.

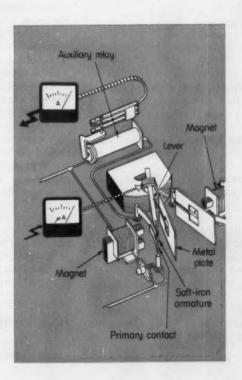


Intricate blind passages

can be produced in internal walls of a plaster-mold casting by using a wax sheet between the parts of the core. The wax sheet is positioned in the coring mold so that coring material fills shaped holes in the wax to connect the two portions of the core. The wax is vaporized in the normal core drying cycle, leaving a one-piece connected core to form the desired passages. Principle employed in wave guide developed by Atlantic Casting and Engineering Corp., Clifton, N. J.

Magnetically shielded lever

provides increased contact pressure in a meter relay. When current being measured exceeds a preset value, the lever passes through a slot in the magnetic shield and is attracted by an auxiliary electromagnet. Principle employed in meter relay development by P. Gossen & Co., GmbH, Erlangen, Germany.



Cam Dynamics via Filter Theory

OPTIMUM cam curves have been the object of much thought and research in recent years.

Although special applications have given rise to many criteria of merit, those that cover most high-speed applications are:

- 1. Limitation of maximum slope.
- 2. Minimization of peak acceleration.
- Avoidance of transient disturbances such as those introduced by discontinuities in the acceleration function.

This article is concerned largely with the third of these criteria. A practical approach is to minimize the discontinuity of the second derivative or to avoid it altogether. Another approach considers the magnitude of the peak third derivative as a quantitative measure of the degree of second-derivative discontinuity.

It is possible, for instance, to modify a parabolic rise in an arbitrarily small region near each transition to produce a rise with virtually no more peak acceleration than that of a parabolic rise and yet have no acceleration discontinuities. A simple flaring out of the evolute¹ at these regions does this. The actual cam contour differs from a parabolic contour by so little that it would not be reasonable to suppose that one curve could be good and the other bad.

The acceleration on the modified curve would be so nearly discontinuous as to be no appreciable improvement over the parabolic rise. In terms of the third derivative this can better be stated in that the peak third derivative, though no longer infinite, would still be very large. Minimization of the third derivative would thus appear to be a more suitable criterion than simple avoidance of acceleration discontinuity.

The third derivative, however, is in many ways an unsatisfactory criterion. Whereas many dissipative physical phenomena are functions of the first time derivative and many conservative ones are functions of the zeroth and second, there are no physical phenomena that are functions of the third time derivative. It is therefore difficult to appreciate the significance of a numerical statement of its magnitude. There is certainly very little use that can be made of its value. At best one must try to see it as the rate of change of acceleration-induced force.

One might well wonder, why in the field of cam design, dynamics problems are considered in terms of specially contrived criteria and terminology. In any other field, generalized filter theory would be applied. It has been extensively developed, and a wealth of material is readily available. Best of all, in generalized filter theory, results are expressed in terms of actual displacement perturbations.

Filter Analogy for Cams

In the usual applications of filter theory, the filter network undergoes design to provide a suitable rela-

References are tabulated at end of article

Well-known principles of filter theory can be adapted to cam design to obtain favorable dynamic characteristics. A kin of the common "cycloidal" profile, a generalized half-cycloid serves as a building block in the synthesis of practical cams having few or many events.

THEODORE WEBER Jr.

Chief Engineer Cam Engineering Div. Howard Holmes Inc. White Plains, N. Y.

tionship between an indefinite input function and the resulting output function. In cam design, the input function is operated on to give a suitable output from a given intervening mechanism.

The cam contour is a function that is periodic in a period of one cam revolution. When the function can be simply expressed as a harmonic series, it can be analyzed as a steady-state signal impressed on a passive network. Most contours, however, comprise a series of curve segments such as dwells and transitional curves connecting such dwells. Such a contour involves too many arbitrary constants to permit any valuable generalization as a whole.

The Building-Block Function: To generalize a contour, it is expedient to devise a building block function with the following properties:

- 1. The function should have few arbitrary constants.
- Any conceivable contour should be expressible as a simple combination of partial functions.

The following is such a function:

$$Y = W_n(X)$$

$$= \begin{cases} \frac{n\pi}{\Delta X} X - \sin \frac{n\pi}{\Delta X} X & X > 0 \\ 0 & X < 0 \end{cases}$$
 (1)

It has but one arbitrary constant, $n/\Delta X$, and can be combined to form an infinite series defining any cam curve between any two points with arbitrary terminal ordinates and slopes.

Since function $W_n(X)$ and its slope are zero at

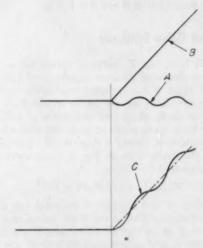


Fig. 1—The building-block function, $Y = W_n(X)$, and its components.

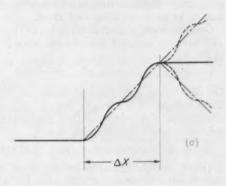




Fig. 2 — a, a generalized cycloid with N even and, b, the standard cycloid as a special case of the generalized cycloid for which N=2.

X=0, no series of such functions can define a curve having a nonzero initial ordinate and slope. However, any such curve can be considered to be the sum of a suitable straight line and a normalized curve in which the initial ordinate as well as slope is zero.

Since the additive straight line need not enter the dynamic consideration, such a series can represent a truly general cam curve, normalized if necessary. The W function of Equation 1 defines the transition from a line congruent with the negative X axis to a sinusoid for X > 0, the axis of which is a straight line with a slope equal and opposite to the initial slope of the sinusoid. It is curve C which is the sum of curves A and B in Fig. 1.

Cam Curve Synthesis

If from one W curve is subtracted an identical curve displaced an even number n of half-cycles to the right, a rise between two dwells results as in Fig. 2a. If to any W curve is added an identical curve displaced an odd number n of half-cycles to the right, a curve will be generated with a succeeding straight line having a slope double that of the axis of the sinusoid as in Fig. 3. Such curves may be expressed as

$$Y = W_n(X) - (-1)^n W_n(X - \Delta X)$$
 (2)

This is the generalized cycloidal rise for which the familiar cycloidal rise is the special case in which N=2 as in Fig. 2b. Since two W curves are required to produce a generalized cycloid, one W curve, Fig. 1c, is a generalized half-cycloid. From these properties, it can be seen how a complete series of generalized half-cycloids can satisfy any combination of terminal ordinates and slopes.

Consider next a normalized arbitrary cam curve with nonzero terminal ordinate and slope as shown in Fig. 4:

$$Y = Y(X) \tag{3}$$

Let the initial and terminal points of the curve be connected by a straight line S. Suppose the straight line S is subtracted from the function. The residual function, shaded in Fig. 4, is

$$Y' = Y(X) - (\Delta Y/\Delta X)X \tag{4}$$

It passes through zero at its beginning and end and may therefore be expanded into one-half of a Fourier sine series:²

$$-Y' = \sum_{n=1}^{\infty} \sin (n\pi/\Delta X) X \quad 0 < X < \Delta X$$
 (5)

If the coefficients of this series are inserted in the series of generalized half-cycloids,

$$Y = \sum_{\substack{h = 1 \\ n = 1}}^{\infty} \frac{b_n W_n(X) - (-1)^n b_n W_n(X - \Delta X)}{(6)}$$

The resulting function will be the original normal-

ized cam curve, Equation 3, having the proper adjoining straight-line sections.

The original curve must have slopes which approach those of the adjoining straight line sections as they approach the respective transitions. This, however, is the only kind of curve of concern here.

Generalized Half-Cycloid Analysis

The universality of the generalized half-cycloid as a building block for all cam curves terminated by adjacent sections of constant slopes has been demonstrated. Remaining is the analysis of the dynamics of one such function. The analysis can then be expanded by the principle of superposition to any cam curve to the extent that the mechanism approximates a linear system.

Unfortunately, such an analysis must presuppose a knowledge of the transfer function of the mechanism driven by the cam. Here, it is assumed that the mechanism characteristic can be approximated by mass A being displaced by the cam follower through a massless linkage with compliance C and that viscous friction B applies (bearings adequately lubricated). Such an approximation will apply roughly to a large number of cases and other cases can be analyzed in a similar way.

The free-body force equation of such a mechanical system driven by a generalized half-cycloid is

$$A\frac{d^{2}Y}{dt^{2}} + B\frac{dY}{dt} + C[Y - W_{n}(X)] = 0$$
 (7)

0

$$A\frac{d^2Y}{dt^2} + B\frac{dY}{dt} + CY = CW_n(X)$$
 (8)

$$=\omega C\left(t-\frac{\sin\omega t}{2}\right) \tag{9}$$

where

$$X = \frac{\Delta X}{n\pi} \omega t \tag{10}$$

the LaPlace transform of which is³

$$(As^2 + Bs + C)Y(s) = \omega C \left(\frac{1}{s^2} - \frac{1}{s^2 + \omega^2} \right)$$

Assume the condition of the system is less than critically damped, and that the damping constant is

$$\alpha = B/2A \tag{12}$$

The characteristic undamped angular frequency is assumed to be

$$\beta_o = C/A \tag{13}$$

and the characteristic angular frequency,

$$\beta = \sqrt{\beta_o^2 - \alpha^2} \tag{14}$$

The transform becomes

$$Y(s) = \frac{\omega C}{A} \left[\frac{1}{s^2 [(s+\alpha)^2 + \beta^2]} - \frac{1}{(s^2 + \omega^2) [(s+\alpha)^2 + \beta^2]} \right]$$
(15)

Fig. 3-A generalized cycloid with N odd.

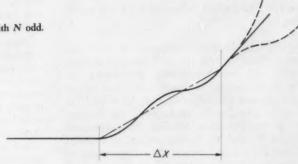
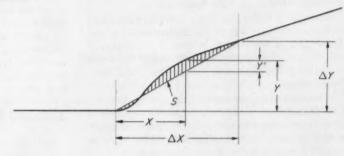


Fig. 4—A normalized arbitrary cam curve as a series of generalized half-cycloids.



Then

$$Y(t) = \zeta^{-1} Y(s) = \frac{\omega C}{A} \left\{ \frac{1}{\beta_o^2} \left[t - \frac{2\alpha}{\beta_o^2} + \frac{1}{\beta} e^{-at} \sin(\beta t - \psi_1) \right] - \frac{1}{[(\beta_o^2 - \omega^2)^2 + 4\alpha^2 \omega^2]^{1/2}} \left[\frac{1}{\omega} \sin(\omega t - \psi_2) + \frac{1}{\beta} e^{-at} \sin(\beta t - \psi_3) \right] \right\}$$
(16)

where

$$\psi_1= an^{-1} rac{2lphaeta}{2eta^2-eta_o^2} \ \psi_2= an^{-1} rac{2lpha\omega}{eta_o^2-\omega^2} \ \psi_3= an^{-1} rac{2lphaeta}{2eta^2-eta_o^2-\omega^2}$$

The steady-state part is

$$Y_{s}(t) = \frac{C}{A} \left\{ \frac{\omega t}{\beta_{o}^{2}} - \frac{2\alpha \omega}{\beta_{o}^{4}} - \frac{\sin(\omega t - \psi_{2})}{[(\beta_{o}^{2} - \omega^{2})^{2} + 4\alpha^{2}\omega^{2}]^{1/2}} \right\}$$
(17)

The transient part is

$$Y_{T}(t) = \frac{\omega C}{A\beta \beta_{o}^{2} [(\beta_{o}^{2} - \omega^{2})^{2} + 4\alpha^{2}\omega^{2}]^{1/2}} \times \left\{ [(\beta_{o}^{2} - \omega^{2})^{2} + 4\alpha^{2}\omega^{2}]^{1/2} \sin(\beta t - \psi_{1}) - \beta_{o}^{2} \sin(\beta t - \psi_{3}) \right\} e^{-\alpha t}$$
(18)

The importance of the steady-state part of the solution is that it would be the behavior of the system if the curve segment were periodic in twice its own interval $2\Delta X$ without any disturbances due to transitions from other segments. This is the part of the solution which may be studied for each curve segment independently. The importance of the transient part is that it shows the transitional transient disturbances, the error that would be committed by considering the curve segment to be periodic in twice its own interval $2\Delta X$.

The significance of the transient part of the solution is best appreciated when the bracketed portion is constructed graphically as in Fig. 5.

Vectors V_1 and V_3 are the transients arising from the straight-line and sinusoidal parts, respectively, of the generalized half-cycloid. Vector V_t results from subtracting the latter from the former to give the net transient as expressed by the bracket. All three are to be considered as rotating vectors diminishing exponentially according to the factor after

the bracket. The fraction before the bracket is simply a scaling factor.

Avoiding High-Frequency Components: Note that the resultant vector will be small when ω is small compared with the characteristic or resonant frequency of the system. A small value of ω assures that the phase-angle difference will be small. The other factor affecting the smallness of the resultant vector is the difference between the component amplitudes V_1 and V_3 . Certain values of α give a minimum difference between the hypotenuse of the right triangle giving V_1 and the vector V_3 . It will be noted, however, that even here reducing the value of ω tends to bring the values of V_1 and V_3 closer regardless of any other quantities.

Although a really thorough investigation would require actual insertion of the parameters of a particular case, a perfunctory review of Equations 17 and 18 and the diagram, Fig. 5, shows the value of avoiding high-frequency components in a camcurve function.

When the transient components are appreciable, it is necessary to consider the transient responses of all the curve segments of a cam and their interaction with each other. Here it must be noted that Equation 10 is contingent on a constant cam-shaft velocity. The phase relationships between the transients of successive initiation points can be quite sensitive to small changes in such velocity. An initiation point is either the beginning or end of a segment. This is obvious when one considers that the frequency of the oscillation depends on the system parameters while the time interval between successive transient initiations depends on cam velocity.

Since speed in a cam application is seldom either predictable or constant, one must assume that the transients arising from different initiation points can be in phase. Therefore, their absolute magnitudes must always be added. Transients arising from common initiation points may be added vectorially.

Aside from improving cam characteristics by reducing spurious displacements, minimizing high-frequency content in the curve segments simplifies cam analysis by minimizing the error committed by neglecting the transient functions and their interrelationships and by considering only the steady-state response of each curve segment independently.

Higher Harmonics to be Avoided

If minimization of high-frequency components were the only cam criterion, there would be no reason to use any curve between two dwells other than the standard cycloidal rise, since it includes only the fundamental in its harmonic expansion. Actually, there are many other considerations that must at times be taken into account. All that is necessary, however, is to satisfy such conditions with the in-

troduction of the fewest and lowest possible harmonics.

For those who are still primarily concerned over the second-derivative discontinuity criterion, it is interesting to note that any finite series of generalized half-cycloids is inherently free from secondderivative discontinuities.

Many widely used cam curves having good dynamic characteristics such as the trapezoidal acceleration and nonsymmetrical acceleration types will expand into rapidly converging harmonic series. The smallness of their higher harmonic coefficients attests to their excellence although there is no reason why such higher harmonics should be included at all as they certainly serve no useful purpose. A better cam would result if the series were truncated after the minimum number of terms necessary to accomplish the purpose of the curve.

It so happens that in using the generalized halfcycloid as an analytical building block the tendency to use the smallest number of terms in order to save work is also likely to produce the best cam.

Probably the most common reason for modifying the cycloidal rise is reduction of the peak acceleration. The cycloid has a maximum acceleration 57 per cent higher than that of a corresponding parabolic rise.

A General Purpose Cam Rise

Let the conditions for a good general-purpose cam rise between two dwells be minimization of peak acceleration as well as harmonic content. A seemingly obvious solution would be to expand the parabolic rise into a harmonic series

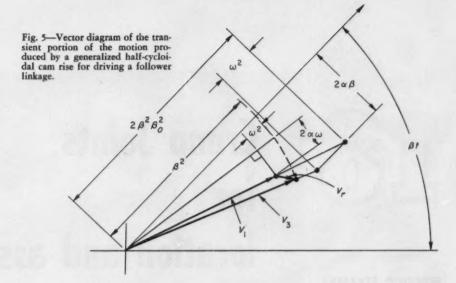
$$Y = K_1 \sum_{h=1}^{\infty} \frac{1}{(2h-1)^3} \sin (2h-1) \frac{2\pi}{\Delta X} X$$
 (19)

and truncate at a certain harmonic depending on which of the two criteria is given greater weight. Note that the infinite series gives the parabolic rise which is the ultimate in peak acceleration reduction while truncation immediately after the fundamental gives the cycloidal rise which gives the ultimate reduction in harmonics.

Unfortunately, such a series truncated after N terms gives least-squares deviation from the parabolic rise attainable with N terms. Actually, as N increases without limit the peak acceleration approaches, not that of the parabolic rise, but a value 18 per cent in excess of that value due to nonuniform convergence of the acceleration series (obtainable by twice differentiating Equation 19), commonly known as Gibbs phenomenon.⁴

The terms of a series giving minimum peak acceleration are not orthogonal.² Therefore, all coefficients are altered every time an additional term is included in the truncation of the series. The difficulty of their determination, therefore, increases rapidly with increased numbers of terms, especially since the series involves an iterative approximation.

Fortunately, the inclusion of only two terms, the first and third harmonics, gives the following optimum series:



$$Y = K_2 \left(\sin \frac{2\pi}{\Delta X} X + .023 \sin 3 \frac{2\pi}{\Delta X} X\right)$$
 (20)

Since a curve without polar symmetry in the interval ΔX is not being sought, it may be assumed that the optimum curve will be periodic, not only in twice its interval $2\Delta X$ but also in ΔX . The expansion of Equation 5 would therefore contain only even terms. Thus, instead of using the series in which all odd terms are zero, the series of Equation 19 is used in which

$$n = 2h \tag{21}$$

The scaling factor K_2 is determined by differentiating Equation 20 to give

$$\frac{dY}{dX} = K_2 \frac{2\pi}{\Delta X} (\cos \frac{2\pi}{\Delta X} + .069 \cos 3 \frac{2\pi}{\Delta X} X) \qquad (22)$$

and equating to the terminal slopes known to be required.

Scaling to Suit Terminal Conditions: Scaling will be found necessary in many cases in which a function must be synthesized to meet special conditions. It is always necessary after truncating an infinite series expansion. In scaling a function to suit terminal conditions, the odd and even terms of Equation 5 should be separated and a scaling factor applied to each. The factor for the even terms affects only the sum of the terminal slopes while the factor for the odd terms affects only their difference. Since even terms only appear in the corresponding Equation 5, only one scaling factor K_2 is necessary in Equation 20.

The curve of Equation 20 has a peak acceleration only 27 per cent higher than that of a parabolic rise. It is considered by some engineers to be a near-optimum general purpose cam curve between two dwells and is recommended unless there is a compelling reason to do otherwise. It has been programmed for automatic data processing as have many of the other commonly specified functions.

Role of Programmed Computer

Fortunately, the increased use of automatic data processing allows today's engineer greater choice of cam curve functions since he is no longer confined to those for which tables exist. Such data-processing equipment is particularly suited to the iterative solutions which arise so frequently in this type of work. It allows for automated analyses for individual curves which may, for instance, terminate in constant nonzero-slope sections on the generalized cycloidal basis requiring only the terminal slopes and ordinates as input information. Data processing by a computer also allows for evaluation of the ordinates of a function defined by curve as Y = f(X), automatically. Moreover, when such a function exists only as a table of ordinates, such ordinates need not be defined at small intervals since they can be subject to curvilinear interpolation as by fitting with an Nth degree polynomial if the function is not periodic. By suitable choice of N, errors in the empirical data which may have resulted from scaling a curve can be smoothed out.

These and many other possibilities, coupled with modern numerical machine-tool control specially adapted to the cutting of cams, has greatly reduced the time and effort involved from the moment the bare requirements of a cam have been established to the actual realization of the hardware.

ACKNOWLEDGMENT

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18

Crimp Joints for location and assembly

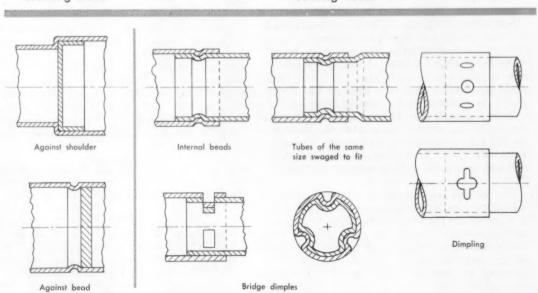
FEDERICO STRASSER Santiago, Chile

RIMPING is a versatile assembly method. Crimp joints are made by deforming one or both work pieces to make a solid fastening. The process needs no additional material or parts. It's fast and economical. A selection of the many kinds and uses of crimp joints is illustrated here.

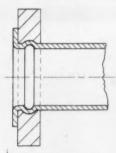
Care must be taken to avoid excessive deformation in crimping. Some of the joints shown could be made stronger by more drastic forming, but strength has been sacrificed to keep forming stress within reasonable limits. Many of the forms shown are round in cross section. Analogous forms of square or rectangular cross section can be joined in the same way, if generous corner radii are provided to minimize crimping stress concentrations in the corners.

Locating Parts

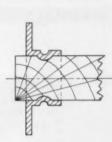
Joining Tubes



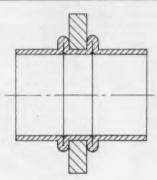
Joining Tubes and Solids



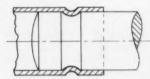
Groove machined in plate



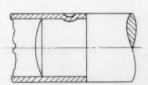
Soft solids, like wood or rubber, that need no preparation



Tube to plate



Groove machined in rod

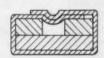


Dimple. and shoulder machined in rod

Joining Solid Pieces



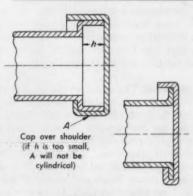
Hole drilled to hold dimple

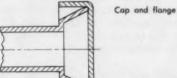


Two solid pieces assembled with stamping



Making Caps Stay On





Flare for low crimping stress

Design factors for

PLASTIC SLEEVE BEARINGS

GEORGE CARLYON

Vice President, Manufacturing Cadillac Plastic & Chemical Co. Detroit, Mich.

PLASTIC sleeve bearings are used in numerous applications where abrasive or corrosive ambient conditions exist, where lubrication would be difficult or impossible, or where noise levels must be kept low. Correctly applied, plastic bearings provide long life and reliable performance.

Materials: The principal plastic materials currently used for small sleeve bearings are nylon 6/6, nylon 6, Zytel 103, Teflon, and Delrin. These materials are thermoplastic in nature, and the bearings are usually produced by injection molding, although for small quantities, or for special configurations, they may be fabricated from sheet, rod, or tube stock. Massive plastic bearings (molded or machined from stock) are sometimes used in intermittent-motion applications or where other special conditions exist. For general applications, plastic-bearing design tends toward a thin sleeve as the bearing surface, backed up by a metal holder.

Loads and Speeds: PV factors, Table 1, are good guides to the design of plastic bearings, especially when the bearings are to run dry or with only initial lubrication. These values should always be tempered,

however, by an understanding of the properties of the material under conditions of use. The most important of these properties is cold flow. For materials with high flow rates, low loads are recommended and relatively high shaft speeds are permissible.

Lubricated bearings can sustain relatively high loads. The bearing should be designed to hold the temperature rise of the plastic to less than 100 F and to dissipate most of the heat through the shaft.

Fit and Clearance: Plastic bearings (except strip type) are usually press-fitted into metal housings. However, even a low-interference fit causes a change in inside diameter. Machining the bore to size after stability has been reached is recommended.

Recommended clearances between shaft and bearing vary with the material and with diameter and thickness of the plastic bearing. In general, clearances should be larger than for metal bearings. Reason: Metal bearings wear faster than the plastic ones, and after a comparable period of operation, clearance in a metal bearing is actually greater than that in a similar plastic bearing.

For dry or partially lubricated operation with 10 F or less temperature rise, a 1-in. shaft-size plastic bear-

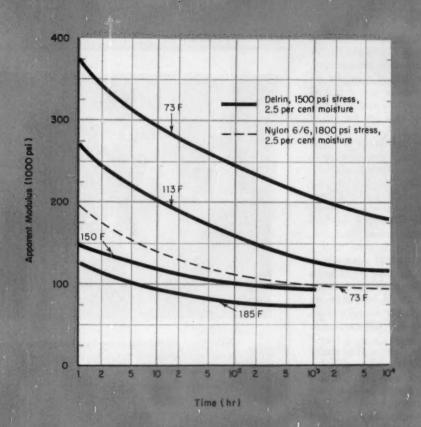


Fig. 1—Apparent modulus of nylon 6/6 and Delrin, plotted against time at various temperatures.

Table 1—Properties of

Property	Maintel -				
	Nylon 6/6	Nylon 6	Teflon	Detrin	
Conflicient of Dynamic				The state of the s	
Friction on Steel	0.34-0.37	0.15	0.04	0.1-0.3	
Water	0.19-0.23	0.10	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0.2	
Off	0.02-0.11	0.05-0.07	***	0.05-0.1	
Fatigue Endurance Limit (pui)	3000	3000	1500	5000*	
antifine wantitames remits (har)	3000	2000	1000	30001	
Service Temperature, max (F)	1501	150	500	185	
service Temperature, may (2)	2004	200	6204	2501	
Thermal Coefficient of					
Linear Expansion (per deg F)	5.0×10-8	4.8×10-8	6.9×10-8	5.5×10-	
			(77-212 deg)		
			11.1×10-8		
			(32-77 deg)		
PV Value** (pei × fpm)					
Dry	500-1000	800-1000		1600	
	3000§	30009			
Water Lubrication	1000-1500	1000-1500	1000-3000	1600-2000	
	4000\$	4000\$			
Oil, Initial	2000	2000	5000-20,000††	3000-5000	
	30004	30001			
Oll, Wiek	50,000-70,000	*******	*******	10,000-15,000	
Water Absorption at 160 F					
(per cent by weight)					
50 per cent RH	3.5	2.5-3.0	None	0.2	
100 per cent RH	8.5 8.5	9.0	None	1.4	
Submerged Length Increase Caused by	5.0	9.0	None	1.4	
Meisture, 160 F (per cent)					
50 per cent RH	0.6	0.6	None	0.2	
100 per cent RH	2.5	2.3	None	0.62	
Submerged	2.5	2.8	None	0.62	

*At 73 F and 100 per cent relative humidity.

†At 150 F and 100 per cent relative humidity.

‡Intermittent operation (15 min on, 30 min off).

†Heat-stabilized nylon (Zytel 103) can be used to 275 F for continuous operation, 250 F for intermittent

are reasonable design values, not maximums. For applications with no variation of load, arance expected, values shown can be increased by 1.2 to 1.25.

PLASTIC SLEEVE BEARINGS

ing, 1 in. long, with a wall thickness of 0.0625 in. should have a clearance of 0.004 to 0.006 in., or about 0.5 per cent of bearing diameter. Recommended relative clearance increases as diameter decreases, Table 2. These clearances are suggested minimums for continuous operation, and will provide a minimum clearance of 0.005 in. per in. of shaft diameter.

Because thermoplastics have coefficients of linear thermal expansion considerably greater than those of conventional bearing materials, design consideration must be given to this property. The increase in volume produces an increase in wall thickness and a reduction of the bore. Obviously, therefore, the thinner the bearing wall, the less total bore reduction will result from a given thermal variation.

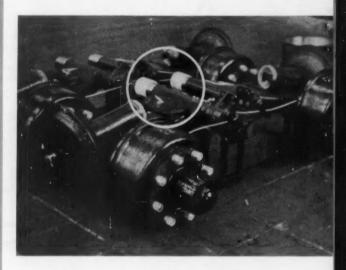
In the l-in. shaft-size example bearing with a 0.0625-in. wall, a minimum diametral clearance to provide freedom over a typical temperature range is 0.004 in. But if the wall thickness were reduced to 0.024 in., minimum clearance could be 0.0025 in. And if the wall thickness were increased to 0.094 in., clearance should be a minimum of 0.0085 in.

Frictional Heat: Important in the design of plastic bearings is the dissipation of heat due to friction. The problem is especially acute because of the low heat conductivity of plastic materials, because critical temperatures are lower than those of metals (see maximum service temperatures, Table 1), and because thermal deterioration usually destroys the bearing. For these reasons, the shaft should be metal.

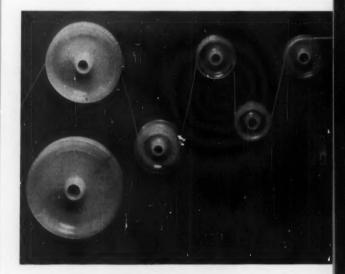
If the shaft can dissipate most of the heat generated, and if no part of the plastic bearing is subjected to heat concentration, massive plastic-bearing construction is acceptable. Examples are: 1. Lightly loaded bearings running at relatively low speeds. 2. Wheels rotating about axles. Here, the load is applied to a continuously changing bearing area, and heat does not build up at any one point.

Where the amount of heat generated is too great for dissipation through the metal shaft alone—and this occurs in the majority of cases—some heat must be conducted away through the surface of the plastic bearing. A thermodynamic steady-state condition must be established wherein the temperature of the hot bearing surface remains below the maximum service temperature of the plastic. This condition is usually achieved by making the plastic bearing very thin, and by placing its nonbearing surface in direct contact with a good thermal conductor.

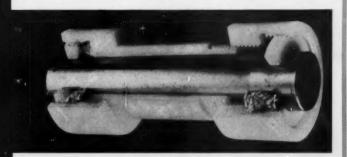
Material	Shaft Diam (in.)	Clearance (in.)
Nylon 6/6, Nylon 6,		
Teflon, 70-150 F	0.25	0.002-0.003
	0.50	0.003-0.004
	0.75	0.004-0.000
	1.0	0.004-0.000
	1.5	0.006-0.008
	2.0	0.008-0.010
Delrin, Zytel 103,		
Teflon, 70-250 F	0.25	0.002-0.004
	0.50	0.004-0.008
	0.75	0.006-0.012
	1.0	0.008-0.015
	1.5	0.010-0.018
	2.0	0.012-0.021



Nylon swivel bearings on truck tandem assembly need no lubrication and are not affected by road grit. This area of tandem assembly, when mounted on chassis, is difficult to reach if lubrication were required.



Nylon pulleys with integral bearings for textile machinery run without lubrication, hence cannot contaminate cord. Pulleys are quiet running, long lasting.



Five-part nylon marine propeller-shaft housing is unaffected by salt-water corrosion and provides lubrication-free bearing for inaccessible area of boat. Flanges permit tight seals through the hull, and threaded washers provide means of adjustment on packing glands during installation.



Crawler tracks on dragline use nylon bearings (obscured by housing and mud) because no lubrication is needed and because imbedded grit does not score shafts.



Nylon fhp-motor housings with integral shaft bearings reduce manufacturing costs by one third compared to assemblies with inserted bearings.

Photos, courtesy Spencer Chemical Co.

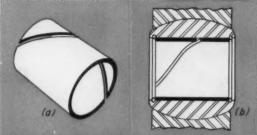


Fig. 2—Plastic "strip" bearing, a, is cut from sheet, strip, or tubing stock. Position of strip bearing, installed in housing, b, is maintained by retainer rings.

Since the rate of heat transmission through the plastic is a function of the temperature difference between the hot and cold surfaces, the cold-surface temperature must be kept as low as possible. Means of accomplishing this are: 1. Providing adequate mass of surrounding metal. 2. Controlling ambient temperature. 3. Extending amount of surface through which heat passes from metal to ambient.

Lubrication, of course, reduces the coefficient of friction between rubbing surfaces and acts as a heatdissipation medium. Liquid lubricants provide a more efficient heat-transfer medium than solid lubricants.

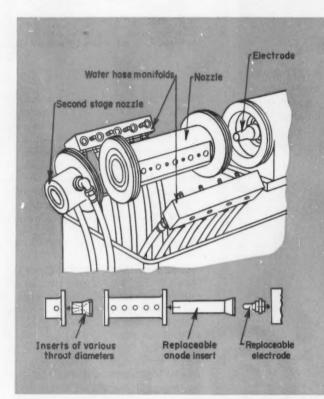
Cold Flow: More critical in plastics than in most metals is the factor of cold flow, or creep. Although most plastic materials have a high initial rate of deformation, the rate decreases with time, and after a certain point becomes negligible. Total allowable deformation often must be held within close tolerance limits. Since the rate of cold flow is not affected by a change in wall thickness, total flow can be kept within a desired limit by designing the bearing with a sufficiently thin wall section.

To calculate total deformation after a given time, the plot of apparent modulus versus time is used, Fig. 1. Moisture content of nylon changes quantitative values of the curve but not the shape. Locating the curve for a particular moisture condition requires knowing only one point on the new curve. Through this point, a parallel to the basic curve can be drawn.

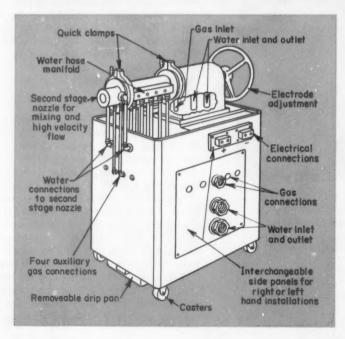
Strip Bearings: Frequently, a bearing need not be machined from a piece of solid or tubular material, but instead, can be formed with a piece of plastic cut from sheet, strip, or tape of the required thickness, or by diagonally slicing a length of tubing, Fig. 2a. Cutting the piece at an angle and just short of the full size required to line the holder, Fig. 2b, leaves a small void which allows for dimensional fluctuation caused by temperature and humidity variations. This safety factor can prevent failure of the bearing when it is used in conditions substantially different from those for which it was designed.

Alignment of the bearing and the shaft is critical. Imperfect alignment will overload small areas of the bearing and cause early failure. For this reason, housings are usually made self-aligning.

Detachable Components Make

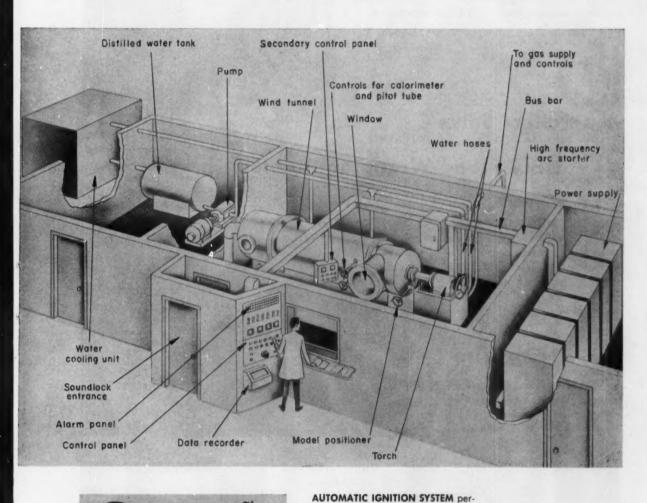


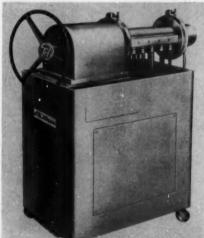
EASY ACCESSIBILITY is designed into a high-powered plasma forch with detachable nozzles and replaceable electrodes. Manifolds eliminate frequent coupling and uncoupling of flexible water hoses that serve the cooling water jacket. Interchangeable throat inserts furnish variation in plasma velocity. First and second-stage nozzles are held in place by quick clamps for fast changes.



TORCH IS MOUNTED on a dolly cabinet that contains water, gas, and electrical connections in a convenient package. Electrode position is adjusted by a large handwheel.

Plasma Torch Easy to Service

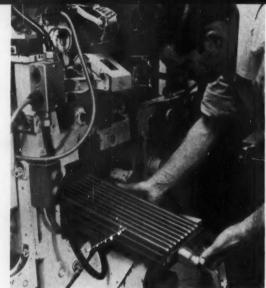




mits torch to be fired remotely by pushbutton wihout damage. Complete torch operation can be controlled from a remote-control panel, making possible torch operation in wind tunnels and controlled-atmosphere or vacuum chambers.

Plasma flame torch, for use in the power range from 50 kw to 1000 kw, was developed by Thermal Dynamics Corp., Lebanon, New Hampshire.

substituting rollers for the conventional heat-sealing platen in a bread wrapping machine helped adapt it for use with new polyethylene wrappers. Difficulty with polyethylene is that at sealing temperatures it's apt to stick to any warm surface it slides across. Rollers transmit the necessary heat, but offer no wrapper-tearing sliding friction. Platen may be replaced for intermittent runs using the older type cellophane or waxed-paper wrappers.

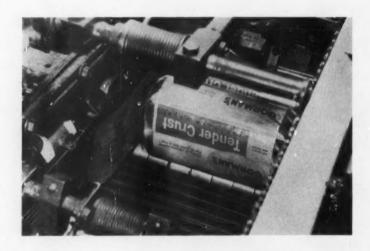


Rollers Solve

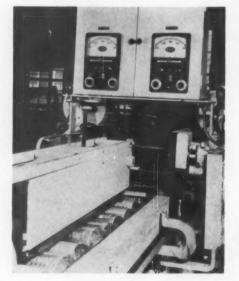
Sticky Bread-Wrapping Problem

GLASS FIBER BELTS PROTECT wrapper ends from similar sticking and tearing problem. Rollers were not completely satisfactory on the bulky end folds that took more heat and pressure to seal. Teflon-impregnated belts provided the answer here.

KNOBS ARE EQUIPPED with friction clutches to discourage "knob twirlers" on the bread wrapper temperature controls. They must be depressed to change controller set points. Although temperature indication is not essential,



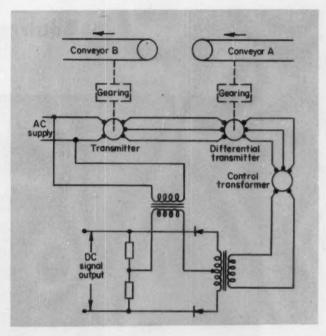
Nashua engineers feel it helps impress operators with importance of proper temperature settings.



Bread wrapping machine that accommodates polyethylene wrappers is a redesign by Nashua Corp., Nashua, N. H., of its basic bread wrapping machine.

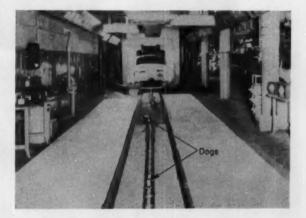


SYNCHRONIZATION OF ADJACENT CON-VEYORS is accomplished by a regulating system which senses the relative speed and position of both conveyors. If conveyor B runs ahead of conveyor A, the control system increases speed on conveyor A, thus preventing a possible empty space on conveyor B. If conveyor B is lagging, conveyor A is slowed before a jam can occur. This is done with a synchro transmitter geared to conveyor B to make one revolution for each car space that passes. Synchro differential transmitter is similarly gegred to conveyor A. Relative shaft position between synchro transmitter and synchro differential transmitter produces an output signal from the control transformer. The control transformer ac output signal used with the phase-sensitive detector produces a dc output, whose magnitude and polarity indicate relative position of the conveyors. Detector output is used as a regulating signal to correct speed of conveyor A.

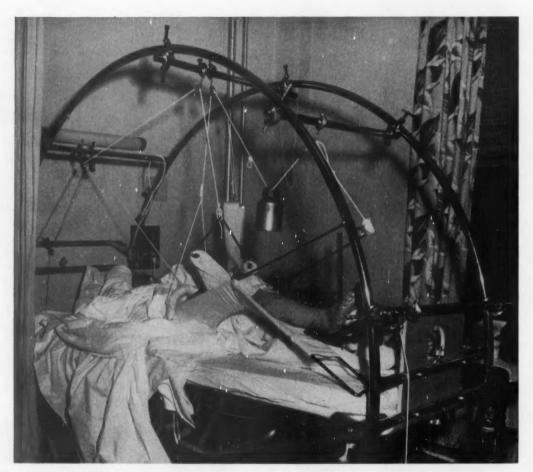


Servo Circuit Synchronizes Conveyor System

DOLLIES CARRY car bodies in a typical assembly line. Dogs on the conveyor catch the dollies and pull them along until they pass off the end of the conveyor line. Conveyors are driven by dc variable-speed motors. Servo control to synchronize conveyors was developed by The Clark Controller Co., Cleveland, and reported by A. E. Lewis.

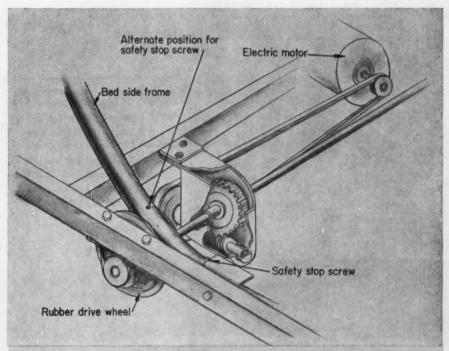


Squirrel-Cage Design Brings



MOUNTED BETWEEN stainless-steel hoops, a new hospital bed allows many patients to perform services for themselves that otherwise would take a nurse or attendant. For instance, the patient can tilt the bed to his own satisfaction and can raise or lower back and knees with a simple gatching lever. Gatching is a jackknifing operation. The hoop-like side frames provide clamping for traction supports at any angle.

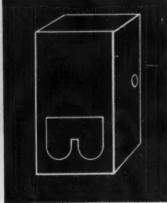
Versatility to the Hospital Bed



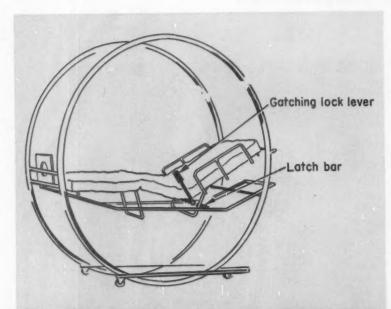
BED IS TILTED by an electric motor geared to a rubber drive wheel. The drive wheel is shaped to the tubular side frame of the bed. A safety stop is positioned to catch a stop screw in the frame to keep it from tilting in a dangerous head-down position if someone "freezes" on the control button. An alternate threaded hole in the frame allows the screw to be moved for certain types of head-down treatment.

INVENTIVE PATIENTS found the bed could be rocked pleasantly by switching the double-throw switch back and forth. To keep from burning out contacts due to increased amperage generated by this use, a switch guard was designed which permits full operation, but through a more complicated pattern over a center detent.





Squirrel-Cage Design Brings Versatility to Hospital Bed (continued)





INSTEAD OF CRANKS to raise and lower knees and back, the bed has a gatching mechanism similar to that in an adjustable beach chair. Pulling a convenient lever operates a box-like cam to release the latch bar until the bed can be moved to the desired position.



WEIGHTS ARE HELD outboard by a pulley system to permit normal bed operation without interfering with cervical traction. Stryker CircOlectric Bed is produced by Orthopedic Frame Co., Kalamazoo, Mich.

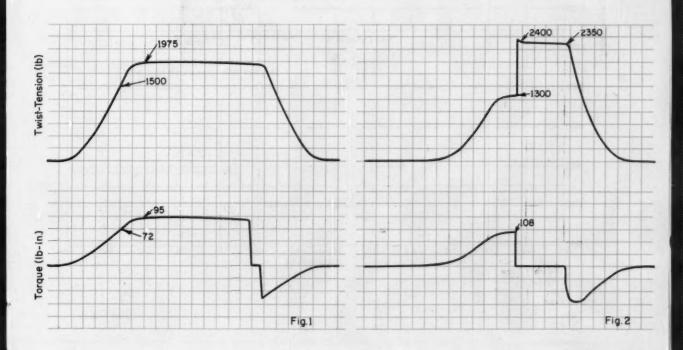
How Much Torque Tightens a Screw?

Present rules of thumb offer very specific torque values to get a desired screw tension. Plating and surface finish may alter these figures more than an unwary designer expects. Here are the surprising results of a brief series of tests.

W. M. HANNEMAN

Executive Engineer Shakeproof Division Illinois Tool Works Elgin, Ill. RULE of thumb says that a soft steel machine screw should be stressed to about two thirds of its ultimate strength. Since production facilities are not equipped to measure this tension quickly and easily, torque is measured as an indirect gage of tension. Where there is a definite and known relationship of torque to tension, this method is quite reliable.

Some of this torque is used to overcome friction on threads and face of screwhead or nut. A commonly accepted figure for the comparative amount



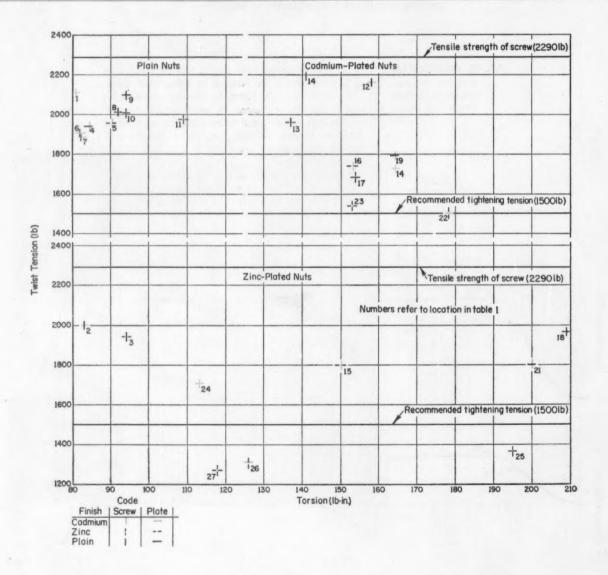
of torque so used is 90 per cent. It seems obvious that individual cases of surface treatment or coating would vary widely from this figure, and that frictional characteristics of the surfaces involved would have a great bearing on the final results. Preliminary reports from a series of tests made with 1/4-20 nuts and screws of various finishes support this suspicion.

Twist Tension: Most screws failed before measured tension reached a figure that corresponded to the ultimate strength of the screw. In some cases, the screw could not be tightened to the 1500-lb figure that represented the recommended 2/3 ulti-

mate strength. As the screw is tightened, it is subjected not only to tensile stress, but to a torsional stress as well. Thus combined stress will reach the ultimate strength of the screw before the pure tensile strength will. Call the smaller tensile force "twist tension."

The sample of data from the torque testing machine in Fig. 1 shows that at 1975 lb twist tension, produced by 95 lb-in. torque, the screw has reached its elastic limit and begun to stretch. To achieve the desirable tension of 1500 lb, the chart shows 75 lb-in. of torque would be needed in this particular case.

Fig. 2 shows that with a combination of zinc screw, nut, and test plate torque increased to 108





TEST PROCEDURE

Tests were made on cadmium, zinc, and plain finish screws and nuts of ½-20 thread sizes. In order to eliminate as many variables as possible, a quantity of indented hex head screws 1¾ in. long and 7/16 in. across flats was produced from the same coil of wire, and threadrolled in the same lot. And a quantity of ½-20 double chamfered hexagon nuts was made in one lot. To represent the work surface against which the nut bears, 1-in. by 1-in. by 0.045 in. cold-

rolled steel plates were provided. Some of each of these objects were cadmium plated, some zinc plated, and some left plain. From these test specimens 27 different combinations could be tested.

The machine in which the tests were made was specially designed to apply either torque or pure tension as desired by the tester. Strategically placed load cells sensed torque and tension. The equipment recorded torque and tension on a strip chart for permanent record.

Table 1—Summary of Test Results

Test No.	No. of Tests	Serew	Pinish*	Plate		nate Twist sion (lb) Range		te Torquo -in.) Range		(lb-in.) for lwist Tension Range
740"	rests	perew	21 11 1	Pinte	AVE	Kango	AVE	nange	Avg	uranta
1	3	C	P	C	2108	1950-2200	80	67-88	55	51-58
2	5	P	2	C	2000	1850-2100	83	72-95	60	50-70
3	7	P	Z	Z	1944	1850-2200	94	80-124	61	58-67
4	3	C	P	P	1942	1925-1970	84	83-85	62	61-63
5	3	C	P	Z	1960	1950-1980	90	83-98	62	60-63
6	3	2	P	0	1902	1875-1930	82	80-85	62	35-66
7	3	P	P	C	1887	1840-1930	83	80-83	65	63-67
8	4	P	P	Z	2011	1900-2125	92	85-109	69	65-73
9		P	P	P	2100	1950-2280	94	99-105	72	68-77
10	3	Z	P	P	2017	1900-2100	94	93-95	74	73-75
11	3	Z	P	5	1975	1925-2000	100	100-115	78	75-80
12	4	P	C	C	2156	2125-2200	158	150-170	91	85-95
13	3	P	C	Z	1963	1840-2150	187	110-150	94	75-105
14	5	P	C	P	2186	2140-2300	141	120-152	100	93-103
15		C	Z	E	1795	1700-1860	150	102-210	107	80-145
16	3	C	C	8	1740	1710-1760	153	145-100	126	120-135
17	4	C	C	P	1680	1640-1760	154	140-170	133	125-140
18	. 5	P	Z	P	1970	1850-2100	209	200-220	133	125-150
19	4	C	C	P	1784	1750-1825	164	180-180	141	140-145
20	5	C	C	C	1724	1675-1775	164	150-180	145	135-150
21	4	a	2	P	1803	1790-1830	200	190-215	150	140-178
23	3	Z	C	C	1505	1425-1600	178	175-180		ens. Too Low
21 22 23 24	3		C	C Z C P	1542	1509-1600	153	145-160		ens. Too Low
24	6	C		C	1709	1600-1800	113	90-149		ens. Too Low
25	. 6	Z	28	P	1363	1250-1500	195	185-210	TwT	ens. Too Low
26		z	2	C	1311	1250-1250	127	105-150		ens. Too Low
27	. 5	Z	2 2	2	1271	1200-1340	118	95-130	TwT	ons. Too Low

*P.Plain, Oiled; C.Cadmium; Z.Zine.

Table 2-Effect of Lubrication

	No. of	Ultimate Twist Tension (lb)		Ultimate Torque (lb-in.)		Torque (lb-in.) at 1500 lb Twist Tension	
Condition	Tests	AVE	Rango	Avg	Rango	AVE	Rango
Dry	5	1977	1925-2010	100	98-120	81	76-87
Olled	5	2015	2000-2025	100	99-100	73%	73-74
Waxed	7	2051	2050-2000	84	72-03	60	53-68

lb-in, as twist tension increased to 1300 lb. At this point the screw began to stretch, showing it had reached its elastic limit. The test machine was stopped and torque released from the screw head. Now the screw was under 1300 lb tension and virtually no torque. Screw tension was then increased by a direct pull without torque (the testing machine has features that allow this to be done). As the curve shows, it was possible to increase the tension on the screw to 2350 lb. With this screw-nutplate combination, ultimate tension was nearly twice as great as ultimate twist tension.

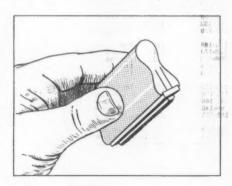
Organization of Data: Results showed that the tests grouped themselves more or less naturally according to the finish on the nut. In Fig. 3 results from the plain unplated nuts stay in a fairly close bunch on the chart. Tests using cadmium plated nuts show a little more spread, but seem to cluster into subgroups according to the finish on the screw. Scatter of the results of tests with zinc plated nuts aroused so much skepticism among the testers that the results were confrimed by a rerun of the test. To prevent confusion, those results are shown on a separate chart. In the tabulation of the results in table 1, the tests were arbitrarily arranged in order of required torque.

Interpretation of Data: These are not extensive tests. They are made on only one size of screw. Not enough data are given to set up any definite formulas for tightening torques. But they are indicative of what may be expected. The results should alert the designer to possible torque vs. tension variations as indicated by the wide variation in test results, and the effect of screw-thread friction on the apparent tensile strength of screws.

Effect of Lubrication: Since friction seems to play a major part in relating torque to tension, additional tests were run on plain unplated screws to find the effect of lubrication on them. Table 2 shows the results of that series of tests. The dry parts had the greatest friction and the waxed parts the least friction. This is shown by the torque values-both those required to achieve 1500 lb tension, and those required to achieve ultimate tension. There was less scatter in the results of the oiled parts than in the other two.

Other Variables: If plating and lubricating variations can cause such a spread in results, what about the effects of other variables such as coarse or fine threads, smoothness of threads, thread tolerances, threads out of pitch or drunken, classes of fits, and high or low cycle applications? Much research needs to be done, theories and formulas worked out and proved before a designer can positively specify a tightening torque with complete assurance that he is getting the screw tension he hopes for.

Tips and Techniques



Rubber Stamp Alignment

The impression of a rubber stamp can be accurately positioned if both end surfaces are marked to locate type lines. Guide lines can be made with a ball-point pen or with strips of tape.—GLEN F. STILLWELL, Manhattan Beach, Calif. 1931-0

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Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, Machine Desiun, Penton Bidg., Cleveland 13, 0.

Tolerancing with Schematics

How often does an engineering department hear these querulous questions:

Do these tolerances need to be so tight?
How were they arrived at?
Are they realistic?

Here is a method that supplies the answers quickly—and offers other advantages.

REGINALD E. STANLEY

Senior Drawing Checker Solar Aircraft Co. San Diego, Calif.

RANSLATING design intent to separate parts drawings has never been an easy job. Too often, the job is more difficult than it need be because of unclear definitions of responsibilities. Spelling out the specific responsibilities of designer, draftsman, and checker is one big step in the right direction.

This article outlines a method that embraces:

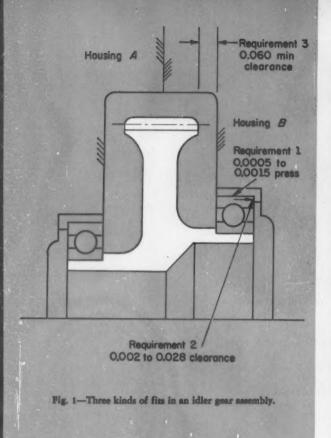
1. The differentiation of designer's and draftsman's responsibilities for tolerances. 2. The derivation of tolerances. 3. The development of tolerances on schematics that also serve as time-saving references for future use. Time can be substantially reduced by the schematic technique for deriving tolerances. In operation, the method assures that the design, drafting, and checking functions contribute to final tolerancing no more and no less than they should.

The procedure starts with the basic document of design.

Layout: A design layout should state all fits that are not covered by company standards. These fits should be chosen with primary consideration as to function but also should be usable in inspection and manufacture when the fits are presented as individual tolerances on interchangeable part drawings.

The layout should be drawn to nominal scale, again taking into account anticipated part tolerances. Obvious assembly conditions need not be specified on layout. That is, clearance holes must clear, parts must be capable of assembly, etc. If any doubt exists as to the detailer's interpretation of the layout, the intent should be specified.

The designer should have immediate access to



TOLERANCING WITH SCHEMATICS

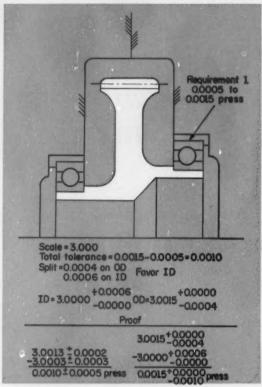


Fig. 2-Tolerances for a press fit.

manufacturing and inspection recommendations. All part numbers other than new design should be exposed as part of the layout. Basic design quality should be approved by project engineering, design management, and representatives from manufacturing, tooling and inspection prior to detailing.

Drafting: After a layout with adequate information is accepted into drafting, the draftsman's prime responsibility is to express detail description in conformance to the requirements of the layout. The checker in turn must prove that this has been done. The chief draftsman should have the authority to refuse a layout he considers incomplete.

The draftsman should make whatever buildups he needs to establish detail dimensions. The checker should carry the responsibility that all necessary buildups have been made and retain a reproducible record of each.

Fig. 1 shows a rudimentary design of an idler gear with three specified fits. This is not intended to represent a complete layout, but it does give enough information to demonstrate a method of drafting and checking which confirm that these three requirements have been met.

A reproducible copy of the layout should be obtained to which any other buildups drafting makes for its own purposes may be added. When completed, this reproducible copy should carry the resultants of all buildups made and a cross reference to $8\frac{1}{2}$ by 11 reproducibles upon which all

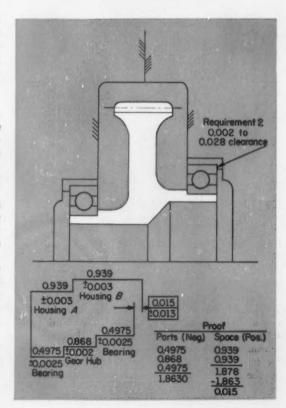


Fig. 3—Tolerances for a clearance fit.

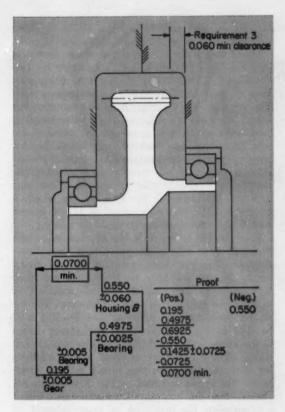


Fig. 4—Tolerances for a minimum clearance.

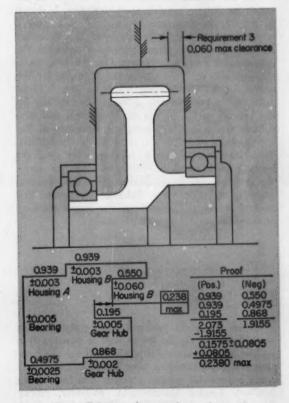


Fig. 5-Tolerances for a maximum clearance.

detail dimensions involved in the stack-up should be shown complete with part numbers. In this way, anyone considering changes to the finished unit can refer to the large reproducible to get an overall picture without confusing detail. If detailed proof is required, any specific proof sheet can be obtained quickly through its reference number.

Press Fit: Detailed proof of Requirement 1 appears in Fig. 2. Usually, proof of diametral fit which involves only two detail dimensions need not be retained in graphic form because it can be repeated easily. This example does illustrate a standard method of determining detail dimensions from a diametral fit. The amount of tolerance available is 0.0010. Since ID is generally more difficult to machine than OD, the tolerance is distributed 0.0004 to OD and 0.0006 to hole. Assume the basic hole system is used. Then, minimum size of hole will be the layout scale to which is added the predetermined hole tolerance, 3.0000, + 0.0006, - 0.0000.

The basic hole system will allow as much repetition of hole size as possible. This is ordinarily preferable from the standpoint of standardized tools and gages. The same thing can be accomplished by systems other than basic hole.

Since the smallest hole plus the maximum press (3.0000 + 0.0015) will give the maximum shaft (3.0015), the predetermined OD tolerance is added to 3.0015 in a minus direction. Proof requires subtraction of the two derived dimensions. Before this is done, the two dimensions must be expressed bilaterally with equally distributed tolerance. Thus, one operation gives the full range of press with the nominal or expected fit, directly expressed. Be sure that the shaft nominal is larger than the hole nominal, before subtracted, or the resultant will be clearance, not press. Tolerances always summate, regardless of whether the operation is addition or subtraction.

Clearance: Schematic proof of Requirement 2 appears in Fig. 3, not to scale. If all dimensions are expressed bilaterally, the proof avoids changes of tolerance signs. Again, one operation gives a nominal resultant with tolerance. And it is again important that, before subtracting, nominal space is greater than nominal parts. Otherwise, the resultant will be interference, not clearance.

Shift between bearing races has been ignored here since it will alleviate binding, not produce it. More tolerance is allowed for space dimensions than part dimensions since internal shoulders are ordinarily more difficult for manufacture and inspection. There is a total of 0.026 tolerance (0.028 – 0.002) to distribute. A total of 0.010 is involved in two purchased parts which leaves 0.016 for three new design dimensions. Any combination of tolerance that adds up to 0.016 will satisfy the design requirement. Co-ordination with production and inspection will reveal the ideal arrangement.

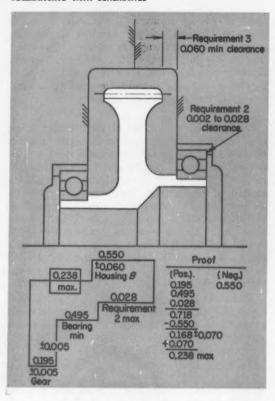


Fig. 6—Tolerances for a maximum clearance measured across a toleranced gap.

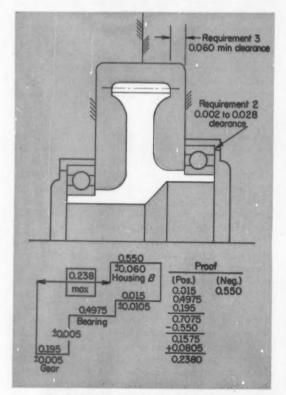


Fig. 7-Tolerances based on a distant datum.

is put into this stack-up because minimum clearance in this case involves total movement of parts.

Fig. 5 shows the same location where maximum clearance is the problem. Note that there are two dimensions from housing B and two dimensions from the gear detail. Whenever a part appears more than once in any buildup, immediate consideration should be given to different detail dimensioning. Schematics can expose very quickly whether details have been functionally dimensioned. In this case, the justification for these two pairs of dimensions is that they are directly used in more important requirements (Fig. 3 and 4). Note that different shoulders are involved in the absolute maximum. The maximum found in Fig. 4 is true only if shouldering occurs on the right bearing.

It is possible to calculate the absolute maximum of requirement 3 by utilizing the right hand shoulders and the maximum gap from Fig. 3. Every dimension that originally established the gap must be used in the new buildup. No tolerance can be used for the stack-up on such a dimension. For instance, the dimension 0.495 for the bearing must be used in Fig. 6 because this is the only figure in the range 0.4975 ± 0.0025 (bearing width) that would allow a 0.028 gap to occur. The possibilities for error increase when this system is used. Ordinarily, the system outlined in Fig. 5 would be advisable. But the longer buildup of Fig. 5 would not outweigh the possibility of error inherent in Fig. 6.

The use of Requirement 2, as a known, in determining Requirement 3, as a maximum, is shown in Fig. 7. In this case, however, Requirement 2 is used as nominal with tolerance. The tolerance on every dimension originally used to calculate Requirement 2 must be eliminated in the new stackup, and also subtracted from the tolerance for Requirement 2. The bearing width in Fig. 7 is an example. It requires the deletion of ±0.0025 for the bearing width in the stack-up itself, and also subtraction of ±0.0025 from the tolerance of Requirement $2(\pm 0.013 - \pm 0.0025 = \pm 0.0105)$. What happens, of course, is that every time the bearing width increases within its tolerance range, the previous resultant decreases by the identical amount, and vice versa. Inherent error with this method would probably make the longer stack-up across actual shoulders more advisable.

They Say . . .

"Given the right job and good training, most people prefer to do the job as well as possible. It is neither fair to the employee nor good for the company if faulty procedures, poor liaison, or some other factor beyond his control prevents him from doing this."—J. Grant Macdonnell, treasurer, Norair Div., Northrop Aircraft Corp., Beverly Hills, Calif.

Twelve designs for

Simple Assembly

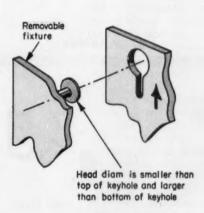
FRANK WILLIAM WOOD JR. Advanced Designs Inc.

Vienna, Va.

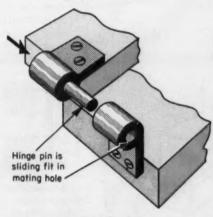
VERNAL L. HUFFINES

Engineer Lofstrand Co. Rockville, Md.

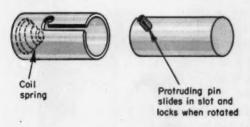
For attaching one part or unit to another, here are a dozen quick and easy methods. They take minimum time and require no tools.



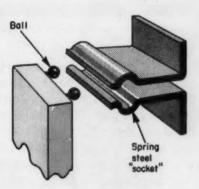
Lift-Out Keyhole



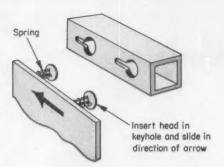
Slip Hinge



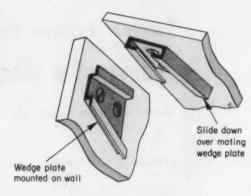
Locking Bayonet



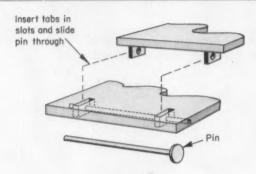
Push-In Ball



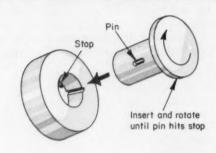
Side-Slide Keyhole



Wedge Slipover

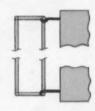


Pinned Tabs



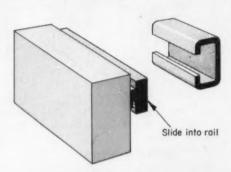
Through Groove



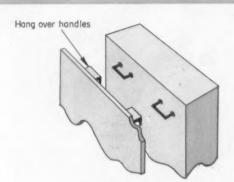


Rack is hooked under bottom clip, then lifted and snapped over top clip

lifted and snapp over top clip

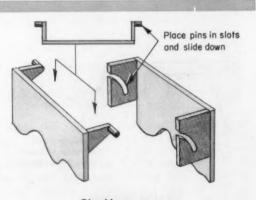


Sliding Rail



Tension Clip

Handle Hangers



Pin Hangers

How sliding affects life of

Rolling Surfaces

THOMAS BARISH, Consulting Engineer, Cleveland, Ohio

HEN two bodies with relative movement are forced together, motion between them is usually classified as rolling or as sliding. Actually, these motions rarely occur in pure form; every rolling contact includes slight, local, lateral displacements. In addition, a third form of motion, called "surface shear," arises when lateral displacements are small and unit pressures high, Fig. 1. Surface shear always occurs—however minutely—before actual sliding starts.

Surface shear and sliding differ greatly in their effects on the material, and the surface areas in which they occur are sharply divided. Studies of fretting corrosion show this point quite well. Fretting corrosion is the corrosion produced at the interface between two contacting surfaces when a slight sliding liberates minute particles that rust rapidly.

The study shown in Fig. 2b and 2c shows that the contact area develops a large center zone of surface shear where the metal appears untouched. Initial

Rolling contacts always include some local sliding and "surface shear." Surface shear consists of minute tangential motions that cause the surfaces to yield in shear, parallel to the surfaces, without the actual sliding of one surface on the other. This article describes the ways in which sliding and surface shear arise, and shows graphically the effect these actions have on allowable loading of specific applications in bearings and gears. These applications are offered as a guide to the solution of like situations where rolling contacts occur.

¹References are tabulated at end of article.

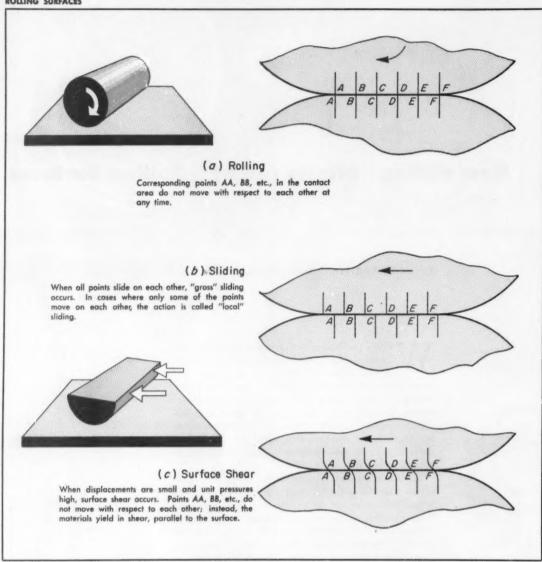


Fig. 1—Three kinds of lateral motion between surfaces in contact can coexist in the same contact area.

surface scratches still show, even though the surfaces have moved. Outside of this area, where sliding begins, the surfaces deteriorate violently.

Action of Surface Shear

How surface shear operates is most conveniently discussed in relation to those common components wherein it occurs.

In rolling bearings and gears, most power losses (friction) and surface deterioration occur in areas of definite sliding. Where there is no sliding, the compression and surface-shear energy of the distorted metal is returned, except for a small hysteresis. Hence, the very low friction of the nearest approach to pure rolling—a ball on a flat plate, Table 1.

Radial Ball Bearings: Sliding in radially loaded

ball bearings occurs because points on the balls travel at different speeds than corresponding points on the race. Point A on the ball, Fig. 3a, travels slower than point B; on the race, A moves faster than B. This is like having two pairs of gears of different ratios locked together. Pure rolling exists only at some intermediate point, C.

In practice, extremely high unit pressures are used on ball bearings by keeping the surface-speed variations low enough so that the action remains almost completely in the region of surface shear.

Angular-Contact Ball Bearings: Surface-speed variations are even greater in angular-contact ball bearings, Fig. 3b. Points A and B on the ball travel at the same speed, but on the race, the speeds of points A and B differ much more than under radial load. For this reason, angular-contact bearings have a

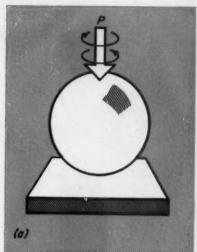






Fig. 2—Experiments for producing and studying fretting corrosion use a ball pressed against a flat plate, a, with load P. The ball is oscillated through a small angle about

the axis through the contact. Contact areas, b and c (about $80 \times$), show center zones of surface shear and surrounding rings where sliding occurred.

Table 1—Measured Coefficients of Friction

Condition	Coefficient of Friction
Ball on Flat Plate	Under 0.00012
Radial Roller Bearing* (short, guided rollers)	0.00098
Radial Ball Bearing*	0.00113
Angular-Contact Ball Bearing* (thrust load)	0.00163

Coefficient of friction at pitch diameter.
2, 8 References are tabulated at end of article.

lower allowable loading-per-ball rating than radial bearings.

In angular-contact bearings, the difference in speed between points A and B on the race would cause the balls to spin if there were much sliding. But the balls neither spin nor change axis except when unloaded. When the load is never relieved, as in tests, the balls develop bands, Fig. 4, indicating no spinning and very little sliding.

Four-Point-Contact Ball Bearings: Surface-speed variations increase still more in four-point-contact ball bearings. These bearings are usually practical only when the application is such that only two points act at any one time.

Roller Bearings: The origin of sliding in roller bearings is more obscure than in ball bearings. Contributing factors include: 1. Manufacturing variations. 2. Imperfect guiding. 3. Off-center loading. 4. Mounting inaccuracies. Because of these factors, coefficients of friction in roller bearings vary more than in ball bearings.

Gears: Pure rolling occurs only at the pitch line of

gear teeth. A typical scoring failure, Fig. 5, shows considerable width at the middle of the tooth, a, where no sliding existed. The narrow pitch line, b, is in the center of this area of surface shear. Above the surface-shear area, sliding occurred, area c, and the scoring failure resulted, caused by excessive local heating.

Friction Drives: Added tangential forces of friction drives change the pattern of surface shear materially from the normal angular-contact distribution. Gross sliding produces no delivered power, and designs must stay within surface-shear limits. The changed pattern of surface shear moves the point of pure rolling, Fig. 6, and changes the drive ratio appreciably.

Surface shear also occurs in the action of automobile tires on a road, Fig. 7. Changes in surface velocities arise because radii OA and OB are not equal. Low modulus of the rubber and deep undercuts of tread design allow surface shear and avoid actual sliding.

Extent of Surface Shear

Surface shear changes to sliding when the tangential force exceeds normal force times coefficient of friction. This applies both to sliding over the entire contact area and to local zones within the contact area. In either case, tangential force depends upon lateral displacement.

Measurements between crossed cylinders⁵ showed about 0.00004 in. motion under surface shear before complete sliding occurred. These tests also showed a break in the curve at a slightly lower point—probably where localized sliding started.

Calculations for angular-contact ball bearings indicate a practical limit of about 0.0008 in. displacement of one surface along the other as the point where surface shear increases rapidly and approaches sliding. Assuming 1/16 in. depth of penetration, the resulting shear stress approximates the fatigue

Fig. 3 - Differences in surface speeds of ball and race affect allowable loading of radial ball bear-ing, a, and of angular-contact ball bearing, b.

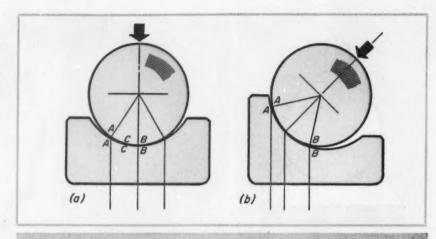


Fig. 4 - Banded balls from angular-contact ballbearing test indicate no spinning and practically no sliding during test.

limit of ball-bearing steel.

Local sliding occurs at the edges of most contact areas, where unit pressures are lower than in the center. However, the band of low pressure, Fig. 8, is quite narrow-at 5 per cent of the distance from the edge to the center, unit pressure reaches 31.2

per cent of maximum pressure.

The proportions of Fig. 8 control the extent of lubrication that can exist in a rolling contact. No lubrication exists in the regions of surface shear, since no sliding occurs. Also, the high unit pressures preclude any possibility of a lubricant except for a film of molecular thickness. Therefore, film lubrication can only exist in the narrow band outside of the surface shear area (except where gross sliding arises, as in gears).

Quality of lubrication and the type of lubricant may change the width of this band slightly by shifting the point of transition from surface shear to sliding. For this reason, certain low-lubricity silicones perform well. Normally, oil has little value

as a lubricant in a rolling contact.

Table 2-Theoretical Life Variation

I dible 1	incorences the	v dilalion
Application	Hertz Stress, S, Varies With:	Life Varies With
Ball Bearing Gear and Roller Bearings	(load) ^{1/3}	S1/9
(line contact)	(load) 1/2	S1/6

Further indication of how much actual sliding occurs in ball bearing contact is obtained by totaling theoretically6 all lateral motions at the surface. These equations agree with measured frictions if sliding is assumed at all points and if the coefficient of friction is 0.06 to 0.07. The same agreement occurs if the area of surface shear is assumed to have practically no losses and the outside band of sliding to have higher normal friction coefficients.

Size Effects

Surface-shear movement in a ball bearing is twice as large for a 2-in. as for a 1-in. diam ball, and the resulting shear stress doubles for similar designs loaded to the same unit pressure. This is one of the reasons why ball-bearing capacities drop rapidly with increase of ball diameter. With constant unit pressure, ball capacity varies theoretically as the square of ball diameter. Actual capacity varies with (diam)1.8 for balls below 1-in. diam and with (diam)1.4 for balls above 1-in. diam. Capacities of large balls (and of angular-contact bearings) would improve if race curvatures were flattened to avoid these increased sliding effects.

The extent of surface shear or sliding displacement also varies with contact-area width in the direction of rolling. As rolling progresses, as in Fig. 1a and 1c, the surfaces lock at point F and release when this point reaches A. Lateral displacement is the numerical product of rate of sliding and time to roll across the contact. Each individual point is shifted parallel to the surface and released as soon as the

contact passes on.

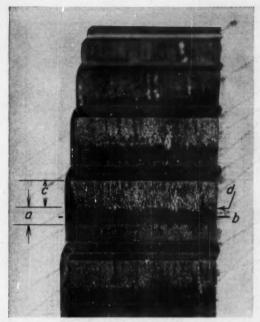


Fig. 5—Typical scoring failure in gear sample shows, a, band of surface shear; b, line of pure rolling; c, area of sliding; d, transition area (from surface shear to sliding, with greatest tearing indicated at the point of change from static to sliding friction).

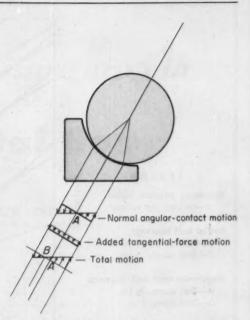


Fig. 6—Tangential force added to normal force of a friction drive changes point of pure rolling from line A to line B.

This theory also implies that gear-scoring limits should include an additional variable for contact width. Since contact width varies with $(load)^{0.5}$, PVT calculations probably would give better correlation with practice if used as $P^{1.5}$ VT (where P = Hertz stress; V = velocity; T = distance from pitch point to contact point).

Subsurface Stresses

The controlling stress in ball-bearing fatigue failures or in gear pitting is not the unit pressure at the surface, but the maximum stress occurring below the surface. Flakes or pits occur because failure originates below the surface. Common usage refers to Hertz stress because the ratio of this stress to subsurface stress is nearly constant. Adding surface shear (or sliding) is rarely considered because the shear at the ends of the contact area has little effect on the subsurface at the center of the contact. Theoretically, surface shear changes the subsurface stress pattern: 1. It increases maximum subsurface shear from 0.30 to 0.34 of maximum Hertz stress. 2. It shifts the location of this stress to more than twice the distance from the surface.

The effect on life of sliding and subsurface shear is summarized in Fig. 9 which shows allowable Hertz pressures currently used in ball bearings, roller bearings and gears. The uppermost curve, showing the highest possible pressure (or the maximum life) is for accurately guided rollers with almost no sliding, with little surface shear, and fabricated of optimum materials. Ball-bearing pressures are high, but loading falls off with ball size and with angular

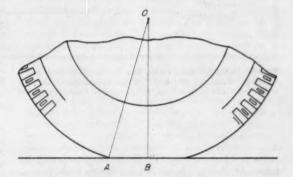


Fig. 7—Surface shear occurs in the action of a tire on a road because radius OA is larger than radius OB.

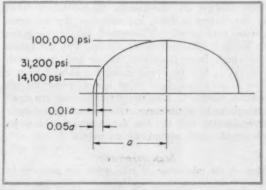


Fig. 8—Rapid rise of Hertz pressure at edges of contact area limits zone of lubrication.

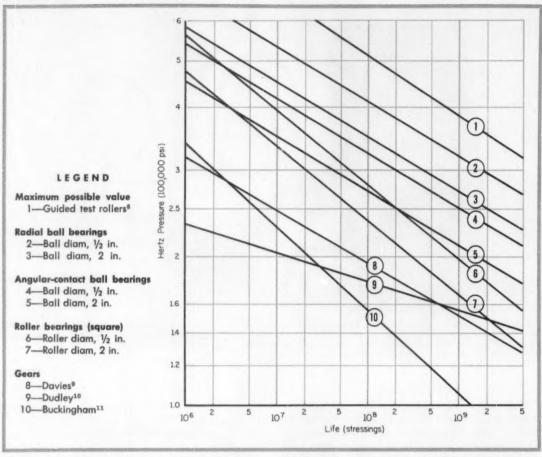


Fig. 9—Hertz pressure versus life for bearings and gears. Bearing ratings are standard (10 per cent failure) life ratings. Gear life is based on highest-quality manufacture and

includes no service factors. Gear curve from Reference 11 includes estimate of dynamic-loading effect.

contact. However, not all of the drop is caused by increased sliding. Some change results from heavysection effects on residual stresses and on heat-

Allowable loading for gears is about one-half of allowable loading for bearings because positive and gross sliding is introduced. Gear authorities agree approximately in the middle ranges where most of the testing is done, but slopes of the life-stress curves vary greatly. Theoretical values are given in Table 2. The reasons for variations in test values are (both from theoretical values and from each other): 1. Any crowning changes a contact from a line to an ellipse (end relief has a similar though smaller effect). 2. Line contact deflections are small enough to be of the same order as surface and body irregularities, and the line deteriorates into a series of islands, each resembling an ellipse.

ACKNOWLEDGEMENT

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the author at the annual meeting of the American Gear Manufacturers Association, June, 1960.

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Determining pressure drop in

Flexible Metal Hose

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NLY limited information has been published on predicting pressure losses in flexible metal hoses or bellows. Data on particular hose and bellows geometry are available,1,2 but not a generalized method. A method of correlation for orifice-like plates evenly distributed along the internal length of a pipe is available.3

Prediction of pressure losses is complicated by the lack of uniformity in internal geometry among the products of various manufacturers. However, pressure loss can be predicted with reasonable accuracy if the internal geometry is known and if the flow is turbulent.

This article presents specific data, obtained by actual laboratory measurement, on pressure loss as a function of water volumetric flow for three hose categories from 1/4 in. to 4 in. diameter. Limited data on losses in flexible hose elbows are also included.

A generalized method for predicting pressure loss evolved from this data is also given. Results compare favorably with those produced by the only method previously available.3 This earlier method involved correlation of data for orificelike plates evenly distributed along the internal length of a pipe.

Specific Data: Variables affecting pressure loss include inside diameter and spacing of convolutions. The configurations tested were in three distinct categories depending on the method of manufacture. These categories are annular, helical, and helical strip. Fig. 1, 2, and 3 show the pressure loss as a function of water volumetric flow for each of these hose categories. Tables 1, 2, and 3 list the physical dimensions of the corresponding hoses.

Elbow Losses: Flexible hoses are seldom used in a straight position. Information on pressure losses in elbows is meager, but available data indicate that the loss factor is normally higher than that accepted for smooth pipe elbows. Fig. 4 shows measured data compared to the accepted curve for smooth pipe elbows. Fig. 5 shows the loss factor as a function of bend angle for a 2.12 inside diameter hose wrapped around a reel.

Generalized Method: Data from Fig. 1, 2, and 3 are converted to dimensionless form and plotted in Fig. 6. The loss factor is shown as a function of the relative roughness of the internal diameter of the metal hose. This equation can be used in conjunction with the Darcy-Weisbach equation,

$$\Delta P = \frac{f\rho v^2 L}{2gd} \tag{1}$$

The hose selected determines the values of the physical dimensions. The value of friction factor can be determined from Fig. 6. First, the value of relative roughness, e/d, and the geometry factor, Nd, are computed. The value of f/Nd corresponding to the computed value of e/d is read from Fig. 6. Multiplication of this figure by Nd gives the value of friction factor f. Direct substitution permits solving for the pressure loss in the hose.

Nomenclature

d = Inside diameter of bellows, in.

e = Average height of irregularity, in.

f = Darcy-Weisbach friction factor

g = Acceleration of gravity, ft per sec2

L = Length of bellows, in.

t = Wall thickness, in.

N = Number of convolutions per in.

p = Fluid density, !b per cu ft

v = Fluid velocity, fps

 $\Delta P = Pressure loss, psf$

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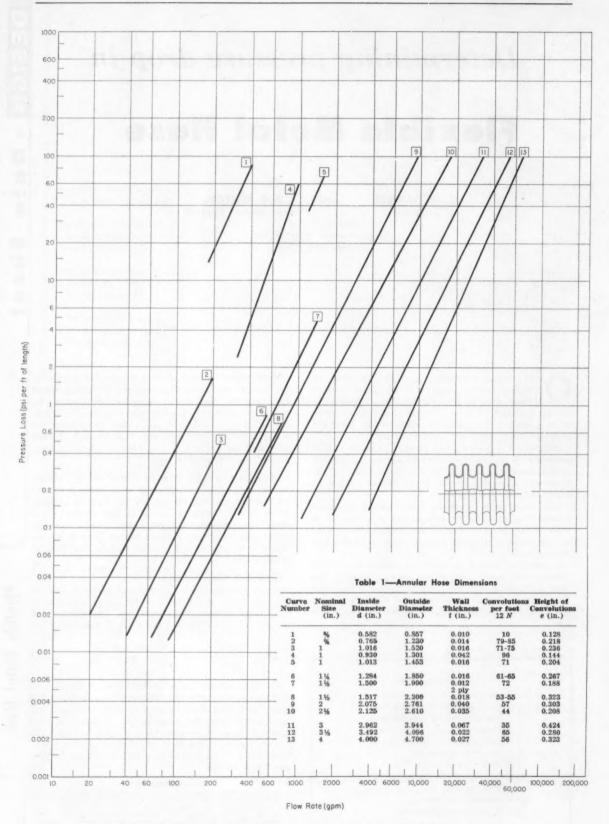


Fig. 1-Pressure loss as a function of water volumetric flow for annular hose.

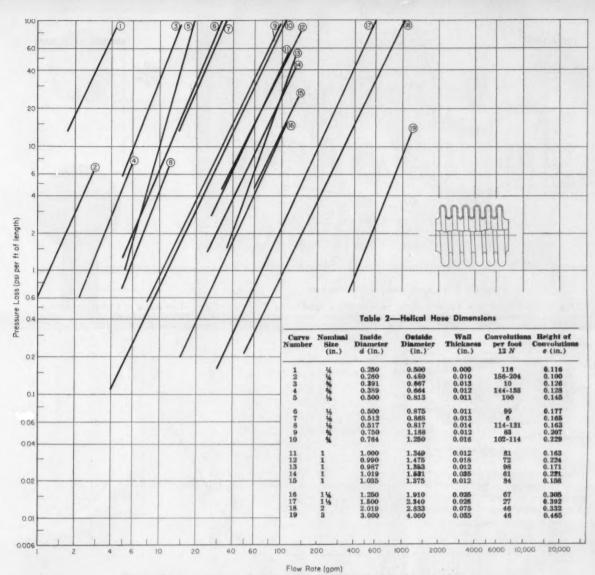


Fig. 2-Pressure loss as a function of water volumetric flow for helical hose.

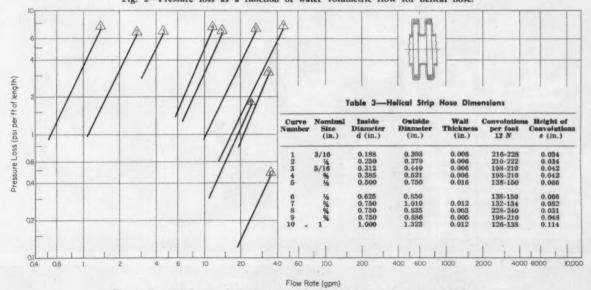
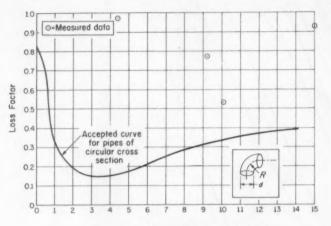


Fig. 3-Pressure loss as a function of water volumetric flow for helical-strip hose.



Ratio of Elbow Bend Radius to Pipe Diameter

Fig. 4—Loss factor as a function of the ratio of elbow bend radius to pipe diameter for a 90-deg bend angle. Measured values for flexible metal hose are compared to accepted values for smooth pipes.

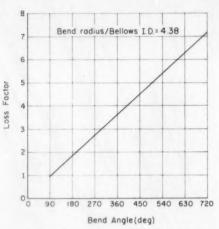


Fig. 5—Loss factor as a function of bend angle for a 2.12 inside diameter hose wrapped around a 9-in. diameter reel.

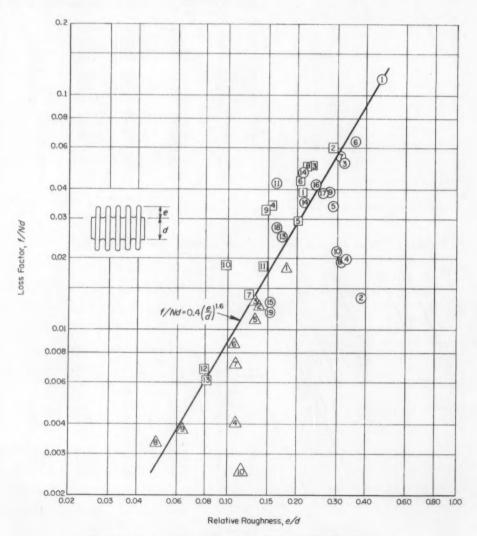
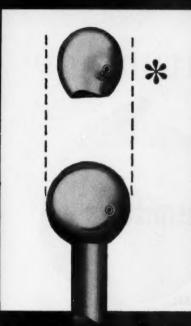
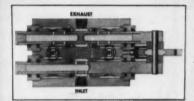


Fig. 6-Pressure loss correlation for bellows and flexible metal hose.



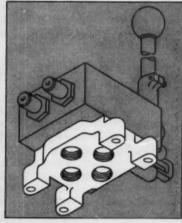
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Application and design factors in

Differential-Pressure Transmitters

V. V. TIVY, P. H. DRINKER, and M. C. KESSEL

The Foxboro Co. Foxboro, Mass.

WHETHER transmitting mechanisms are being bought or built, adherence to basic principles determines design or selection. This article is a discussion of these principles. It includes a consideration of motion and force-balance techniques and their relation to dynamic and ambient conditions. All discussion relates to the differential-pressure transmitter.

Physical Factors: Severity of operating conditions is relative, of course, but must be considered in design or selection of transmitters. Whether electrically or pneumatically operated, transmitters must be capable of performing with the greatest accuracy under the most severe ambient conditions with complete reliability. Temperature-induced stress and strain, chemical corrosion, mechanical erosion, friction, and vibration are ever-present enemies, always on the offensive.

Stress and Strain: Since transmitters are often exposed to extremes of temperature and pressure, the effects of these ambients must be accounted for or output will reflect them as faithfully as it will the measured variable. If an instrument could be built containing absolutely no elastic materials, this

FORCE
BALANCE

MOTION
BALANCE

TO BALANCE

MOTION
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MOTION
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BALANCE

TO BALANCE

Fig. 1-Basic methods of transmitter functioning.

consideration would not be neces-

CORROSION AND EROSION: In order that "wetted parts" can be made to stand up in all industrial atmospheres, designers must often use materials which are not the best suited, to minimize extraneous stress and strain. Typically, Ni-Span C is an excellent spring material, but it is not always acceptable in contact with industrial fluids, and must be protected from corrosion.

DYNAMICS: In the last fifteen years, considerable emphasis has been placed on the frequency response of the various components

making up a control loop.

Should transmitters be capable of following frequencies higher than those of other components in the system? To what extent should high fidelity measure performance? Such questions are becoming more prevalent as frequency analysis grows in usage. Many times it becomes apparent that some filtering in transmitters is desirable. Just how much and in what manner it is employed is an important application factor.

Force and Motion Balance: For many years there have been two



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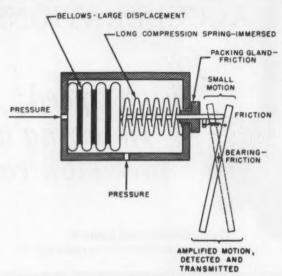


Fig. 2-Main design elements of a differential-pressure transmitter.

basic methods for utilizing the energy of process variables to measure and transmit them. These two means are used regardless of the medium ultimately chosen for transmission—electrical or pneumatic. One type is force balance, the other is motion balance, Fig. 1.

In the first type there is no measure of position, and the mechanism need have no net motion, but it provides no mechanical indication of measurement. It adds energy to rebalance, so it transmits inherently. The second type is calibrated against a spring, so inherently there is an indication, but no rebalancing force or energy is added, hence it does not transmit.

Force and Motion Designs: One particular variable on which both types of transmitters are in quite common usage also imposes about as severe ambient conditions as any. Such a variable is differential pressure. It may be transmitted either by a pneumatic or an electrical signal,

To compare performances of force and motion-balance transmitters, one must be careful to select points of comparison which illustrate only first-order problems. In a transmitter, Fig. 2, these major factors are: Distortion from ambient temperature, overrange pressure and displacement, inertia, friction, accuracy, and cost.

DISTORTION AND AMBIENT TEM-PERATURE: Ideally, all energy of the measurement would be absorbed in the rebalancing force. Unfortunately, this is never the case, for each metallic part exhibits elastic properties. Furthermore, metallic parts change dimensions with temperature. To minimize effects from these two strains, whatever motion of intermediate levers results from measurement changes must be large with respect to the motion resulting from these strains. Levers must be capable of being returned to their initial positions with insignificant force. The whole system should be as slack as possible in the working range.

A motion-balance transmitter rebuilt to become a force-balance transmitter would be the best performing design. Instead of moving l in., the element would not move more than about 0.001 in.—enough to actuate a detecting system. If distortion occurs, feedback will restore the levers to the proper position against a relatively low gradient.

Overrange Pressure: It is progressively more difficult to cope with overrange as element motion increases. A bellows for large motion and a diaphragm for small motion are the two most common elements now in use. Overrange protection and the minimizing of errors after overrange are more practical with a diaphragm simply because it can

be backed up by a solid stop, whereas a moving bellows wall is more difficult to protect. The less the working motion of an element and the more flexible it is, the more easily compensation for overrange can be applied.

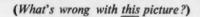
DISPLACEMENT: In measuring the differential pressure of liquids, displacement is always objectionable. The more displacement, the more inertia, and the poorer are dynamic characteristics. The only good reason for designing any significant displacement into a differential pressure transmitter is to provide an accurate indication of calibration without the use of auxiliary power. It is reasonable to add transmission to such a device only when local indication independent of power is desirable.

INERTIA: Obviously, a device with a total motion of 0.001 in., and with no sliding or rolling members, will follow higher frequencies with less attenuation than one which moves I in. While the advantage of greater fidelity may not be usable in differential-pressure measurement, the same transmitter is convenient for pressure, level, and even temperature. A force design works best.

FRICTION: Purely electrical transmitters have no friction, but pH, emf, resistance, and similar measures are a small percentage of all variables measured. On the other hand, friction is vitally important in transmitters which must indicate flow, level, pressure, motion, and other physical phenomena. The arrangements of transmitter components, the forces involved, the materials of the components, and the nature of their motion all contribute to friction.

ACCURACY AND COST: Meters built with both force and motion rebalance are available with equal accuracies and almost identical static performance, but motion-balance transmitters cost nearly half again as much.

Force Balance Transmitters: Progress from early transmitters to present ones is illustrated in Table 1. Certain aspects in this progression are noteworthy. First, stiffness is reduced each time, thus reducing ambient temperature effects. Second, the percentage of force absorbed by springs has been reduced



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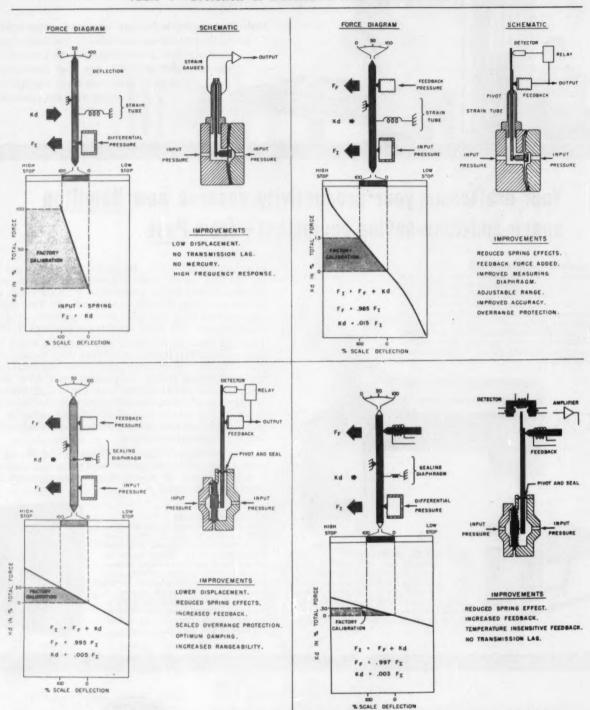
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Circle 495 on Page 19

Table 1—Evolution of Differential-Pressure Transmitters

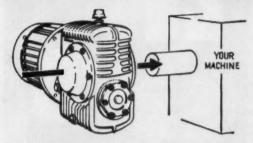


by a factor of 5. Third, overrange errors were reduced. Fourth, filtering was added. Improvement in other factors such as friction, displacement, and cost was less spectacular but, nevertheless, accomplished.

Having examined some of the more important static aspects of transmitter designs, the application factor of dynamics must then be considered, and whatever modifications necessary to accommodate good dynamic performance must be incorporated.

ISA Paper No. ISA-8, "Application Factors in Transmitter Design," presented at the Joint Automotive Control Conference,

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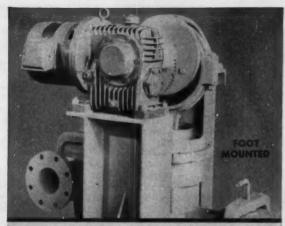
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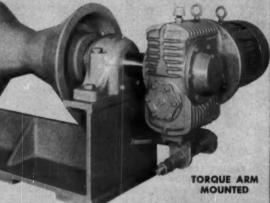
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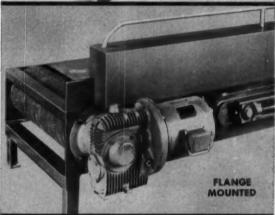
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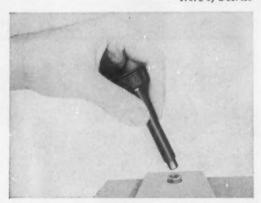






Practical **Design Tips**

No. 3 of a series

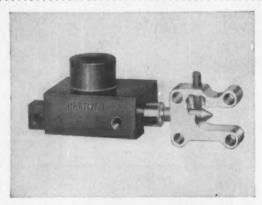


TO LIMIT TORQUE APPLIED TO SOCKET SET SCREWS grind the screw end of a Vlier Torque Thumb Screw to the proper size hex. The amount of torque can be quickly adjusted between 10 lbs. and 125 lbs. Once set torque is reached, knurled ring spins freely, preventing overtightening. Backing off is positive.

Perhaps the applications shown below will suggest ways you can profit from the use of Vlier tools. Many companies have simplified product designwith resultant savings-by substituting these simple, off-the-shelf items for complicated custom devices.



TO SECURE THE DUPLICATOR CARRIAGE of this metal fabricating machine when not in use, the manufacturer uses two Vlier Swivel-Pad Torque Thumb Screws. These simple holding tools with the unique ball-joint pad construction, limit the amount of torque which can be applied, and prevent scoring or damage to the ways. Vlier Swivel-Pad Torque Thumb Screws such as used in this application are available in various sizes and end pressures.



TO PROPERLY POSITION THIS YOKE-SHAPED PART for rotated into a latch assembly, a Vlier S-58 Spring Plunger is used. The threaded stud, extending horizontally, is slotted on two sides. As the stud is rotated, the spring plunger snaps into the slot assuring the proper position of the yoke. Vlier Spring Plungers are available in six nose types; various end pressures.



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Mass. Institute of Technology, Cambridge, Mass., Sept., 1960, 3 pp.

processes

Predicting Results of the Plug-Drawing Process

T. Z. Blazynski, and I. M. Cole, research engineers, Tube Investments Technological Center, Walsall, England.

Mathematical formulae used successfully for the purpose of predicting the behaviour of a metal during plug drawing. Drawing loads and the effect of lubricants and die profiles can be calculated, enabling the efficiency of the drawing process to be assessed.

The basic data needed for use in the formulae are the mean yield stress, which provides a measure of the resistance to deformation of the metal, and the coefficient of friction.

It has been shown, using a 0.12 per cent carbon steel as an example, that suitable mean yield stress values can be obtained from indentation tests. Mild steels of lower carbon content will have lower mean yield stress values and the results of this work will over-estimate drawing loads by about 5 per cent in such cases. For the drawing of mild steel with soap as lubricant 0.050 has been found to be a suitable value for the coefficient of friction. These experimental data, together with the formula in which they are used, are applicable to all sizes of tubing.

Sink is shown to have adverse effect on the magnitude of the redundant work and should therefore, where possible, be avoided. The tendency in planning the drawing passes should be toward combined pure draft and higher effective strain, as this will tend to make the process more efficient.

Institution of Mechanical Engineers Paper No. 2, 1960, "An Investigation of the Plug Drawing Process," 10 pp.

lubrication

Lubricants for Gears

E. L. Will, Organic Research Dept., Monsanto Chemical Co.

Additive requirements for current standard classifications of gear lubri-

More equipment manufacturers choose Fast's Couplings than any other gear-type coupling

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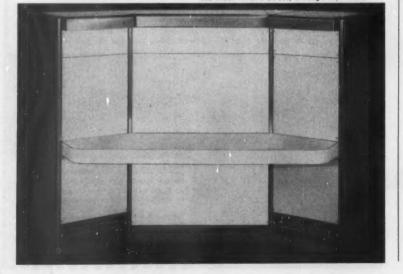


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cants, and a research approach being used to obtain basic information about gear additive requirements. Lubricant classifications are those in the "SAE Information Report on Transmission and Axle Lubricant Types" included in the 1960 SAE Handbook:

Regular-Type Gear Lubricants usually contain no additives. They are comprised of straight mineral oils selected on the basis of viscosity, channeling characteristics, stability, and oxidation resistance.

Worm-Type Gear Lubricants are designed to protect worm gear sets in which high tooth pressures and rubbing velocities are characteristics. Additives are used to enhance oiliness.

Mild-Type Extreme-Pressure Gear Lubricants are designed to have load carrying properties suitable for many automotive transmissions and spiral bevel differentials under severe conditions of speed and load.

Multipurpose-Type Gear Lubricant (API Service GL-4) serves the same purpose as Mild-Type Lubricants but in exaggerated degree.

To select lubricants for a given piece of equipment, four guides are suggested:

- 1. The lubrication recommendations of the equipment manufacturer.
- Recommendations of reputable lubricant suppliers.
- Performance in standard CRC full scale gear tests.
- Compliance with past or present Ordnance Qualification requirements.

SAE Paper No. 217B, "Paradoxical Products—Lubricants for Gears," presented at the SAE National Farm, Construction and Industrial Machinery Meeting, Milwaukee, Sept., 1960, 5 pp.

materials

Creep and Rupture Properties Of Carbon Steels

A. I. Smith, National Engineering Laboratory, E. A. Jenkinson, National Physical Laboratory, and D. J. Armstrong, National Engineering Laboratory, England.

Rupture properties of carbon steels which show normal and abnormal creep properties at high tempera-



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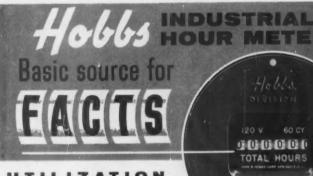
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tures in tests extending to 100,000 hours. A wide range of strength properties is shown to exist. The pattern of results, however, appears reasonably consistent, At the lower end of the strength scale are almost pure irons and at the upper end are steels of moderate carbon content and not low in manganese and silicon. Heavy deoxidation with aluminum of conventional carbon steels results in lower creep and rupture properties than are observed in similar steels deoxidized with silicon; the part played by nitrogen in this effect is considered. In the steels covered, low ductility in long-time service appears unlikely,

Institution of Mechanical Engineers Paper No. 1, 1960, "Creep and Rupture Properties of Carbon Steels," 22 pp.

Properties of High-Strength, Leaded SAE 4140 Steel

William Simon, Westinghouse Electric

An investigation to determine the practicality of substituting a leaded SAE 4140 steel for the conventional grades. Conclusions are:

- 1. The differences in the transverse fatigue, impact, and tensile properties between leaded and nonleaded SAE 4140 alloy steel at hardness levels of 55 and 47 Rockwell C are insignificant for normal applications.
- 2. The transverse fatigue, impact, and tensile strength properties of high-strength leaded and nonleaded SAE 4140 alloy steel are considerably lower than the corresponding longitudinal properties.
- 3. The low transverse properties are caused by inclusions which are commonly found in commercial grades of SAE 4140 alloy steel; these inclusions act as stress-raiser notches and have their major effect in the transverse direction.

As a result of these conclusions, the following recommendations were made:

- Gears, pinions, and other similar parts which are loaded in the transverse direction should be designed on the basis of transverse properties such as those which are reported in the text of this investigation.
- 2. A grade of steel which is less notch sensitive than SAE 4140 steel, possibly SAE 4340 steel; or a cleaner grade of steel such as vacuum-melted SAE 4140 or 4340 steel, should be used for gear and pinion applications which are

heavily loaded in the transverse direc-

SAE Paper No. 220A, "Fatigue, Impact, and Tensile Properties of High-Strength, Leaded and Nonleaded SAE 4140 Steel," presented at the SAE National Farm, Construction, and Industrial Machinery Meeting, Milwaukee, Sept., 1960, 8 pp.

Temperature Dependence of The Elastic Moduli of Several Stainless Steels

F. Garofalo, Edgar C. Bain Laboratory for Fundamental Research, U. S. Steel

Elastic moduli of two austenitic stainless steels at temperatures between 80 and 1000 F. One alloy is a chromium - manganese - nitrogen (Cr-Mn-N) steel and the other a chromium - manganese - molybdenum-vanadium - nitrogen (Cr-Mn-Mo-V-N) steel, and a ferritic stainless steel, modified type 422. The elastic moduli and the temperature dependence of the austenitic steels differ in some respects from those found for the standard AISI 300 grades. A measurable difference in behavior is also found for the modified type 422 steel when compared to a type 410 ferritic stainless steel.

ASTM Paper No. 81, "Temperature Dependence of the Elastic Moduli of Several Stainless Steels," presented at the Sixty-Third Annual Meeting of the Society, June-July, 1960, 12 pp.

Properties of Five Copper-Base Casting Alloys

W. H. Johnson, senior metallurgist, and J. G. Kura, chief, both of Nonferrous Metallurgy Div., Battelle Memorial In-

Mechanical and physical properties of 76 Cu-21/2Sn-61/2Pb-15Zn alloy, 20 per cent nickel silver, 81-4-15 silicon brass, 65,000 psi manganese bronze, and 110,000 psi manganese bronze alloys at various temperatures ranging from -40 to 550 F. The properties are ultimate strength, yield strength, elongation, reduction of area, modulus of elasticity, compressive strength, V-notch Charpy impact strength, Brinell hardness, fatigue, machinability, melting range, patternmaker's shrinkage, density and specific gravity, electrical resistivity, thermal conductivity, and thermal expansion. . . MOL

ASTM Paper No. 77, "Mechanical and)



applications

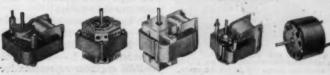
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SPEED	13 RPM	13 RPM	13 RPM	13 RPM	
TORQUE	150 in./oz.	100 in./oz.	150 in./oz.	90 in./oz.	
AMPS, No Load	2.5	1.25	1.2	0.6	
WATTS, No Load	26	13	24	12	
REVERSIBLE	No	No	Yes	Yes	
CONDENSER	None	None	60 MFD	60 MFD	

data based on 24 volts — Intermittent Duty 3 minutes on and 5 off. Both models can also be supplied for 115 volts — 60 cycles.

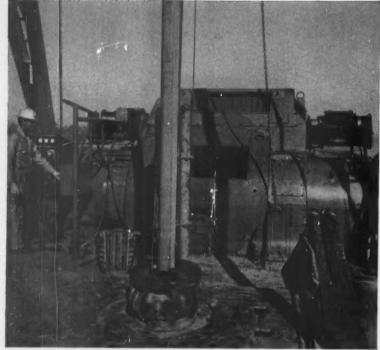
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October 13, 1960



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Brown & Sharpe lubricating pumps help drilling rigs strike oil

There's a carefully-considered reason why designers at Mid-Continent Supply Co. — world's largest independent oil field supply company —

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Twe B&S No. 35 gear pumps (arrows) flood main chain drive (not shown) with oil. Either separately-driven pump will do the job alone.

use Brown & Sharpe pumps to lubricate their big "drawworks."

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B&S pumps were first tried by Mid-Continent several years ago proved so dependable they've been used ever since.

In this customer's own words —
"Brown & Sharpe pumps do the job
we selected them for; have proved
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years". Quite a compliment, from
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To help your machines "strike it rich" — contact Hydraulics Division, Brown & Sharpe Mfg. Co., Providence 1, R. I. — or your nearest B&S engineer-representative.

Physical Properties of Five Copper-Base Casting Alloys," presented at the Sixty-Third Annual Meeting of the Society, June-July, 1960, 15 pp.

hydraulic

Filtration in Mobile Hydraulic Systems

Legrand E. Terry, eastern regional sales manager, Mobile Hydraulics Div., Vickers. Inc.

Present-day need for filtration in hydraulic systems, analysis of some concepts of filtration, and remarks on applications. In the latter category, recommendations are:

- Use of a micronic or oil bath air breather on the reservoir.
- Use of a micronic filter in the return line.
- Relocation of the air breather outside of the engine compartment.
- 4. Emphasis on the proper maintenance of the hydraulic cylinder wiper ring.
- Filtration of the oil from the single acting cylinder drain by introducing it into the return line ahead of the filter unit.
- Possible modification of the reservoir baffle plate and incorporation of a clean-out plate in the reservoir.
- Chrome plating of the cylinder piston rods, thus reducing scoring and excessive wear.
- Adoption of better maintenance practices by user of these vehicles in contaminated areas.

SAE Paper No. 223C, "Mobile Hydraulic Systems Filtration," presented at the SAE National Farm, Construction, and Industrial Machinery Meeting, Milwaukee, Sept., 1960, 10 pp.

Analysis of the Yielded Compound Cylinder

S. J. Becker, senior engineer, Westinghouse Electric Co.

Analysis of the partially plastic range, restricted to plane strain, of the compound cylinder made by shrinking together many concentric cylinders.

For the thick cylinder, initial yielding does not indicate failure, and, in fact, often is beneficial to the strength of the vessel. This is just as true for the cylinder that is compounded by shrinking together several cylinders so as to introduce initial stresses, usually elastic, in the structure.

It is possible to examine the stress distribution and deflections in the yielded cylinder theoretically, to discover what the true strength of the vessel is and what benefit can be achieved from a measured amount of pressure that will cause partial yielding. It is found that there are several answers to the question of strength, depending on exactly the meaning assigned to the term strength, but that the question of benefit from partial yielding has an essentially unique and unusually simple answer.

ASME Paper No. 60-SA-13, "An Analysis of the Yielded Compound Cylinder," presented at the Summer-Annual Meeting, Dallas, Tex., June, 1960, 5 pp.

electrical

Optimization of a Sandwiched Thermoelectric Device

B. W. Swanson, E. V. Somers, and R. R. Heikes, Mechanics Dept., Westinghouse Research Laboratories

Analysis for optimizing the thermal efficiency of a sandwiched thermoelectric device, the analysis coded for a digital computer. Since it is desirable to operate thermoelectric power devices with large temperature drops so that the thermal efficiency is as high as possible, it is necessary to have the thermocouples operate over a large temperature interval. In the present state of material development, no single thermoelectric material is satisfactory for use over the complete temperature range. It is therefore necessary to use different materials in each temperature range.

This may be accomplished in two ways: 1. The materials may be used in stages such that each stage operates over a fixed temperature interval while being electrically insulated from but thermally in contact with the remaining stages. 2. The other method is to form each leg of the couple by joining in series; that is, forming a sandwich structure of the appropriate thermoelectric materials for each range.

Simplified design equations of a thermocouple of sandwich construction, optimized to approximate the maximum thermal efficiency, were coded for an IBM 704. An example shows computed results.

ASME Paper No. 60-HT-24, "Optimiza-

tion of a Sandwiched Thermoelectric Device," presented at the ASME-AIChE Ilcat Transfer Conjerence, Buffalo, Aug., 1960, 6 pp.

Design and Functioning of Electrohydraulic Servo Valves

Roy S. Cataldo, senior research engineer, General Motors Research Laboratories.

Equations of motion of three possible configurations for electrohydraulic servo valves and equations for position servo-mechanisms utilizing these valves when driving a generalized load. Basically the valve configurations differ in the manner in which the main spool is positioned. Three cases are considered.

Case I is the conventional type design whereby centering springs from the main spool to ground are used to position the main spool.

Case II uses the feedback spring connected from the spool to the torque motor armature to position the main spool.

Case III positions the main spool by virtue of a position feedback loop from the main spool to the armature.

A combination of Case II and III has a number of advantages over the conventional type design presented in Case I.

ISA Paper No. ISA-11, "Analysis of Electrohy-Iraulic Valves and Systems," presented at the Joint Automatic Control Conference, Mass. Institute of Technology, Cambridge, Mass., Sept., 1960, 25 pp.

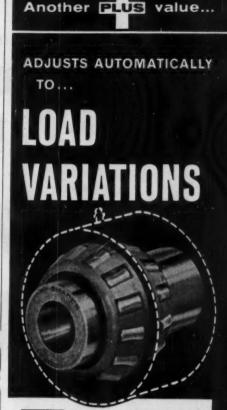
techniques

Literature on Heat Exchanger Dynamics and Control

Theodore J. Williams and Henry J. Morris, Monsanto Chemical Co.

A critical survey of current literature and methods. Conclusions are:

- The distributed parameter model seems entirely adequate for concentric tube exchangers and for the tube side of shell and tube exchangers, provided flow remains in the turbulent regime.
- An adequate representation of shell side flow in shell and tube exchangers has not yet been obtained.
- Frequency response methods are the most common for obtaining experimental data. However, transient response methods for evaluating impulse and pulse responses by comput-



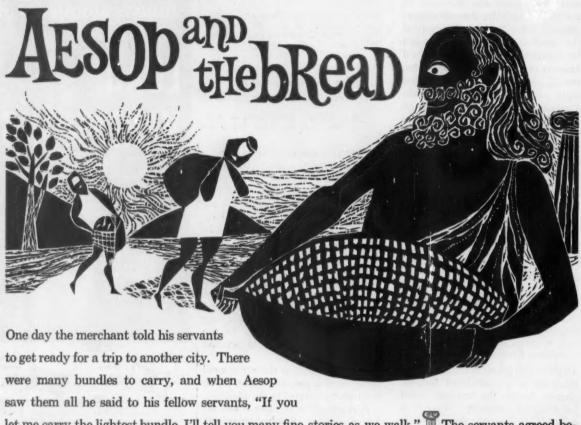
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let me carry the lightest bundle, I'll tell you many fine stories as we walk." The servants agreed because they liked Aesop's stories. But when Aesop picked up the heaviest bundle of all—a large basket of bread — the other servants laughed at him. He barely could manage to carry it. Around noon, the travelers stopped to rest and eat their dinner. Aesop gave each servant a loaf of bread for dinner, so the big basket wasn't as heavy during the afternoon. When the sun went down, Aesop gave each servant a loaf of bread for supper, and the big basket was empty. The next day the merchant and his servants went on to the city. Aesop had nothing to carry but his empty basket, so he told stories to the other servants while they struggled under their loads.

moral: Alert analysis wins out in the end.

Have you analyzed your machines to make sure that proper cylinder designs are providing most efficient production? Ask your Hydro-Line representative to help you. Of course, he might try to sell you a Hydro-Line cylinder or two, but only if you really need them. And his analysis now may save you considerable time and money later.

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cylinder is unsuitable for your application, he'll recommend the proper modified standard cylinder, which has its own stroke or other deviations from catalog stock dimensions. Either way, you can be sure that the best cylinder design is working to help you gain more production and earn more profits.

Look in Sweet's Product Design File (Bulletin 8a-Hy) for standard dimensions of stock cylinders and the address of your nearest Hydro-Line representative. Ask him to analyze cylinder requirements in your plant soon.



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- er analysis should be developed as rapidly as possible because of the economy in testing which they promise.
- 4. Practically no data are available for the dynamics of the laminar flow regime in exchangers. Other important fields for research are the response of outlet temperatures to flow disturbances; the dynamics of condensers containing mixed vapors and/or non-condensibles; and the behavior of reboilers.
- 5. While no general formulas for the optimum control configurations for a specific exchanger have appeared, work to date has shown that the development of a specific control loop for an individual exchanger is not a difficult task.

AIChE Preprint No. 1, "A Survey of the Literature on Heat Exchanger Dynamics and Control," presented at the Joint Automatic Control Conference, Cambridge, Mass., Sept., 1960, 8 pp.

Bibliography on Analog-to-Digital Conversion

Mervin E. Frank, Thompson-Ramo-Wooldridge Products Co.

Approximately 170 titles classified as general, voltage digitizers, position digitizers, and pressure digitizers.

AIEE Paper No. CP-60-1232, "Bibliography on Analog-to-Digital Conversion," presented at the AIEE Fall General Meeting, Chicago, October, 1960, 17 pp.

Heat Transfer Efficiency of Finned Annular Passages

Allan D. Kraus, senior engineer, Countermeasures Div., Sperry Gyroscope Co.

A derivation for the efficiency of a finned annular passage with fins attached to both inner and outer pipe wall. Considering heat-exchange surface for airborne applications, the designer must keep in mind the ideal of minimum weight and volume. While the tendency has been toward the use of the so-called "compact" heat exchangers, it is possible that the finned double-pipe exchanger has installation advantages. In order to utilize the surface of the outer pipe, it would appear desirable and feasible to attach the fins to both the inner and outer pipe.

While the heat-transfer conditions in the trapezoidal wedge-shaped passages are unusual, and additional pressure drop will be introduced, comparison indicates a significant improvement over the bare and finned inner-tube arrangements.

ASME Paper No. 60-HT-3, "Efficiency of Finned Annular Passages," presented at the ASME-AICHE Heat Transfer Conference, Buffalo, August, 1960, 4 pp.

mechanical

Optimum Gear Design

C. W. Genson, gear engineer, Master Electric Div., Reliance Electric and Engineering Co.

A step-by-step procedure to determine gear load ratings and drawing dimensions for various gear applications. This system considers four types of gear geometry:

- 1. Conventional or standard gear design.
- 2. Long and short addendum design.
- Gear and pinion cut oversize or undersize to mate on spread or compressed centers.
- Stub teeth or modified addendum and dedendum for a special purpose.

This system uses Type 1 for gear ratios 1:1 to 1.5:1. Type 2 is eliminated because Type 3, when used in this system, will adjust addendum and dedendum to suit optimum design. Type 4 is considered only when the loads are high and speeds low, or where resistance to shock loads must be provided. Type 3 requires much more time for problem solution, but with the electronic computer this time is measured in seconds.

ASAE Paper No. 60-102, "Optimum Gear Design," presented at the ASAE Annual Meeting, Ohio State University, Columbus, Ohio, June, 1960, 27 pp.

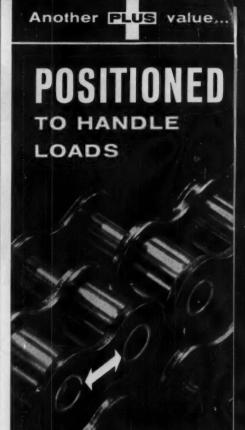
Structural Analysis In the Design Stage

Melvin A. Walch, Engineering Test Dept., Tractor and Implement Div., Ford Motor Co.

Advantages and benefits of design stage structural analysis with particular reference to agricultural power machinery. The same advantages and benefits can be applied to the design of all equipment or structures where strength of components is an important factor.

A number of significant advantages accrue from the establishment and distribution of design loads:

 Design engineering personnel are informed of critical conditions and loads and therefore should produce



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If you need precision in small metal parts you can get it from Torrington—plus exactly the right finish, temper and hardness required for your needs. Moreover, Torrington can produce such parts at high speed and a remarkably economical cost. We are the leading specialist in this field—with the specialized skills, engineering experience and facilities to save you money. If you have small parts to be manufactured in large quantities why not let Torrington solve your entire problem. Let us hear from you and your request will receive prompt action.

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more satisfactory initial designs.

- The strength of all components of the basic structure is more uniform since all designs are based on identical design loads and conditions.
- Design load data, when considered with test results and service data can be modified or extrapolated for future designs.
- 4. Design loads can be used:
 - a. As test loads for prototype testing, thus providing a check on the accuracy of the design and the structural analysis.
 - To expedite the design of modifications, or of subsequently authorized attached equipment.
 - c. To provide data for specifications required by government agencies and by increasing numbers of commercial customers.
 - d. As a basis for evaluating the strength of competitive designs.

SAE Paper No. 219A, "The Advanatges of Structural Analysis in the Design Stage of Agricultural Equipment," presented at the SAE National Farm, Construction, and Industrial Machinery Meeting, Milwaukee, Sept., 1960, 17 pp.

Diesel-Gas Turbine Power

C. G. A. Rosen, consulting engineer, Woodside, Calif.

Flexibility of combinations and diversity of possibilities of the diesel engine-gas turbine combination. The diesel engine is particularly suitable for turbocharging because it thrives on excess air. Other properties and capabilities are:

- The greater the density, the shorter the delay period, hence the smoother, more controllable, and more complete the combustion.
- The higher the supercharge pressure, the less sensitive does the engine become to ei:her the octane number or the volatility of the fuel.
- There is a gain in thermal efficiency due to a reduction in relative heat loss.
- 4. There is evidence that in some forms of compression ignition combustion chambers, the proportion of oxygen that can be consumed increases slightly with increase of density. Thus, the return in power output is somewhat greater than would be expected from the direct increase in density and thermal efficiency.
- 5. As compared with a spark ignition engine, the mechanical efficiency of the compression ignition engine is considerably lower, hence it benefits more by any increase in the effective

DESIGN ABSTRACTS

- 6. Given sufficient intercooling, the gain in both mechanical and thermal efficiency will more than compensate for the power absorbed by the blower at the higher load ranges when the latter is driven mechanically and at almost all load ranges when the exhaust energy is used to drive the
- 7. The practical upper limit of super-charge is reached when the maximum cylinder pressures are such as to cause: a. Scuffing of the piston rings and heavy liner wear, b. Overloading of the bearings, c. Leakage of the cylinder-head joints due to springing of the cylinder-head bolts.
- 8. Supercharging tends very greatly to reduce the ignition delay period. As a result: a. The engine runs quieter and smoother, b. The optimum ratio of maximum to compression pressure is considerably lower and under better control.

SAE Paper No. 212A, "Diesel-Gas Turbine Power," presented at the SAE National West Const Meeting, San Francisco, August, 1960, 15 pp.

Performances of Springs at Temperatures above 900 F

William R. Johnson and Donald D. Crooks, Associated Spring Corp.

Data on the performance of statically loaded spring materials for temperatures up to 1200 F and times up to 1500 hr. At high temperatures, spring failure is usually caused by setting or plastic flow. If this setting occurs under constant load conditions, it is called "creep." Under fixed height conditions, setting is called "relaxation."

Stress relaxation proceeds at a constant rate if the time is plotted on a log basis, and cautious extrapolation of test data may be justified. Heat-set springs exhibit markedly better performance with close to zero or actually negative relaxation, but this is a temporary effect only, dependent on the heat-setting process, and extrapolation of test data may be quite dangerous.

In the range of temperatures, stresses, and times used in these tests, Inconel X, No. 1 temper, appears to be the best of the commonly available spring materials, although one sample of Refractaloy 26 has given better results, particularly as the temperature goes up.

Unpublished data of the International Nickel Co. have indicated that spring temper Inconel X, given the triple heat-treatment of 2100 F for 2 hr, plus 1550 F for 24 hr, plus 1300 F for 20 hr, may be expected to give comparable results at these temperatures. However, this heat-treatment must be applied to already coiled springs, necessitating supporting arbors.

SAE Paper T-44, "The Performance of Springs at Temperatures Above 900 F," presented at the SAE Summer Meeting, Chicago, June, 1960, 5 pp.

Vehicle Steering Fundamentals

William H. Baier, senior research engineer, Armour Research Foundation

Factors which determine the behavior of wheeled vehicles in response to steering. This paper summarizes these factors and points out the part that each plays in determining the lateral motion of the vehicle as it travels along a curved path. The discussion is concerned largely with applications of the theory related to operation of on-and-off-the-road vehicles.

SAE Paper No. 218A, "Vehicle Steering Fundamentals," presented at the SAE National Farm, Construction, and Industrial Machinery Meeting, Milwaukee, Sept., 1960, 48 pp.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to the following organizations:

AIChE—American Institute of Chemical Engineers, 25 West 45th St., New York 36, N. Y., papers 50 cents.

AIEE—American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

ASAE—American Society of Agricultural Engineers, 420 Main St., St. Joseph, Mo.

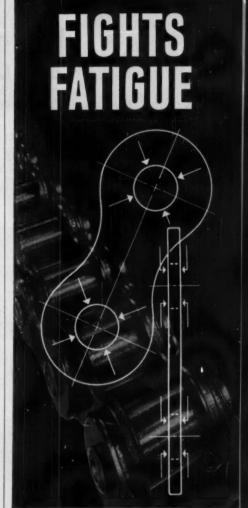
ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

ASTM-American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London S.W. 1, England.

ISA—Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

SAE—Society of Automo'ive Engineers, 485 Lexington Ave., New York 17, N. Y., papers 50 cents to members, 75 cents to nonmembers.



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Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Force Control Switch

Bulletin 49-E describes the force-control switch which automatically triggers from one to four separate microswitches. Models for compression and tensile loads are pictured and described, and tables present full specifications. Subminiature models are also included, 6 pages. W. C. Dillon & Co. Inc., 14620 Keswick St., Van Nuys, Calif.

Circle 721 on Page 19

Woven Wire Cloth

Woven wire cloth Specifications Guide is illustrated with many examples of various types of strainers. Specification sections contain useful information for selecting the right metal, weave, and mesh when ordering woven wire cloth. 36 pages. F. P. Smith Corp., Dept. S-9, 2340 N. Clybourn Ave., Chicago 14, Ill.

Circle 722 on Page 19

Printed-Circuit Connectors

Series 600 Continental connectors are presented in new bulletin. Illustrations of the various types are given in actual size, and engineering drawings present information on sizes and mounting characteristics. Electrical and mechanical ratings are also included. 4 pages. DeJur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.

Circle 723 on Page 19

Ball-Screw Assemblies

Illustrated brochure in color outlines ball-screw assemblies, their applications, and design-operation characteristics. Advantages of the units are pointed out, and actual photographs of applications are shown. Information is also provided on installation, complete systems, special designs, and on representative design data. 8 pages. Kidde Aero-Space Div., Walter Kidde & Co. Inc., Belleville 9, N. J.

Circle 724 on Page 19

Lubricating Equipment

Catalog 10 covers oil cups, oiling systems, dispensers, valves, oil gages, chain oilers. Each unit is pictured and described, and tables provide engineering and dimensional data. 32 pages. Oil-Rite Corp., 2318 Waldo Blvd., Manitowoc, Wis.

Rotary Switch

Catalog which describes in detail recently standardized Series 150,000 hermetically sealed rotary switch is designated D-460. Contained in the catalog are three sections which illustrate 3072 standard designs, in-

The same of

cluding dimensions, drawings, mountings, receptacles, and wiring. Also included are complete control and performance data, environmental conditions, duty cycles, voltage codes, and approximate hold-in resistor values. 13 pages. Ledex Inc., 123 Webster St., Dayton 2, Ohio.

Circle 726 on Page 19

Fittings and Hose

Catalog 4430 describes Hoze-lok Type 30 fittings and hose for high-pressure service. Pictures, drawings, and tables provide all data on the various units, including hoses, connectors of several types, elbows, clamps, tubes, and complete assemblies. 12 pages. Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 727 on Page 19

Thermal Relay

Informative specification sheet provides detailed information on new low-cost circuit breaker featuring model variations with and without auxiliary or alarm circuits. Details on sizes, electrical data, design features, operation, and calibration are included. 4 pages. Dept. NLS, E-T-A Products Co., 6284 N. Cicero Ave., Chicago 46, Ill.

Circle 728 on Page 19

Sealed Switches

Hermetically sealed and environmentfree switches, in basic models, are described and pictured in Catalog 130. Material is also included on variations which are available. Engineering drawings and specifications are incorporated. 18 pages. Control Switch Div., Controls Co. of America, 1420 Delmar Drive, Folcroft, Pa. Circle 729 on Page 19

Aluminum Products

New bulletin provides descriptions, availabilities, and design data on aluminum products. The nonheat-treatable alloys are furnished as sheets, coils, and circles. Information includes applications and physical properties, weights, and dimensions. 4 pages. Fairmont Aluminum Co., Fairmont, W. Va.

Circle 730 on Page 19

Wirewound Potentiometers

High-precision, single-turn, wirewound potentiometers suitable for missile and space-age applications, computer assemblies, calibration controls, servo-mechanisms, and precision industrial-control systems are described in new catalog. Electrical and mechanical specifications

for 28 standard models of linear, nonlinear, and sine-cosine units are contained in a multiple-foldout selector table. Four color-coded outline drawings classify units in terms of case design, clamp-band configuration, and mounting. 6 pages. Fairchild Controls Corp., 225 Park Ave., Hicksville, L. I., N. Y.

Circle 731 on Page 19

Plastics

New catalog lists availability of plastic films, rods, tubes, sheets, and blocks. It shows prices and specifications for linear or semirigid polyethylene sheets and rolls, and similar data for tough Delrin acetal plastics. Two pages are devoted to revised table of properties of the plastics handled. 64 pages. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3. Mich.

Circle 732 on Page 19

Electrical Plugs

Newly designed, revised Series MS catalog fully describes MS-A (solid shell), MS-B (split shell), and MS-C (pressurized) plugs approved to Mil Spec MIL-C-5015. Specific items covered are polarization; coupling methods; shell, insulation, and contact materials; nomenclature; accessories; and a review of specification MIL-C-5015D. Pictures, dimensional drawings, and tables present specifications. 20 pages. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Circle 733 on Page 19

Indicator Lights

Form L-163, "Lights That Enlighten," surveys the subject of read-out indicator lights. Illustrated with life-size photographs, the colorful brochure summarizes seven categories of information-giving lights. Ultraminiature units are among those enumerated. 4 pages. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 734 on Page 19

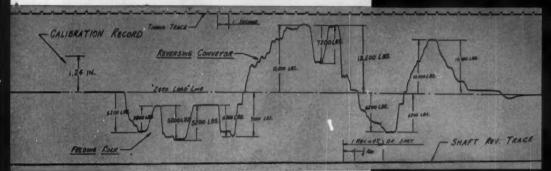
Drafting Equipment

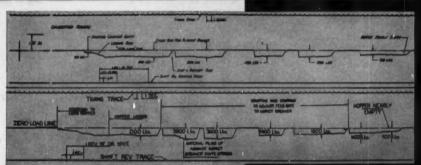
Eighty-one high-quality drafting items are shown and described in four-color Catalog 1960. Among them are Mars-Lumograph Duralar pencils for work on drafting film, Mars-Lumochrom pencils for color coding on tracings, nonreproducing pencils for making temporary work notes on drawings, and a comprehensive selection of other drafting pencils, leads, and holders. Three indexes facilitate location of items of interest. 24 pages. J. S. Staedtler Inc., Hackensack, N. J.

Circle 735 on Page 19

Increased chain drive life assured by **Field Dynamic Load Testing**

the BIG PLUS value





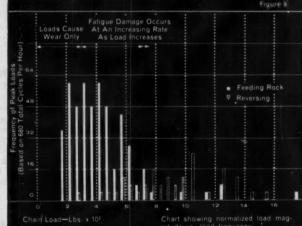
In many drive applications where considerable variations in loadings are experienced, it is difficult to select a chain that will provide maximum service life. Too often, the magnitude and frequency of peak loadings are not accurately known and chain selections are based on insufficient data.

To overcome this difficulty, CHAIN Belt engineers developed equipment for determining dynamic loadings for chains operating in actual service. From this library of data, accurate chain selections can be made to provide any desired life. For example:

A drive operating on an apron feeder was subject to frequent failure. CHAIN Belt engineers, using strain gages on the operating drive and recording actual load patterns with a multi-channel oscillograph, clearly proved that, when handling very large rocks, the maximum operating loads were far in excess of the recommended working loads for the chain. Under these conditions peak chain tensions ranged up to four times the rated working load for the chain. Peak tensions in normal operation handling small to medium-size rock ranged from 1.5 to 2.3, with occasional peaks up to 3.3 times the rated working load. Working with these data, a chain was selected to accommodate the peak loadings and eliminate the frequent costly failures previously experienced.

On many applications analyzed, it has been found that smaller chains (more economical drives) provide the life desired.

Have an unusual or difficult drive selection problem? Talk to a CHAIN Belt sales engineer. He can assure you of proper selections to assure maximum service life. Write CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: CHAIN Belt (Canada) Ltd., 1181 Sheppard Ave. East, Toronto.







If the fastener you now use in your product risks corrosive attack, cannot be reused, costs too much to install, is not strong enough, undermines the effectiveness of your product—consider the versatility and economy of Hy-Gear worm drive clamps. Band and housing are premium stainless steel. Hy-Gear—available with either stainless steel or cadmium plated worm screw—installs easily, has a powerful grip—can be used over and over again.

Available in Three Styles

Safety-collared type is recommended when Hy-Gear is installed in confined areas...Collar prevents slipping of screw-driver speeds tightening.



Non-collared economy type serves equally well when area of application is not restricted by space limitations. Has deep slotted screw for easy screw-driver tightening.



Thumb-screw type to enable hand tightening on laboratory apparatus, appliances and other equipment where frequent tightening and untightening is required.



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HELPFUL LITERATURE

Hydraulic Products

Complete line of hydraulic products for the industrial, marine, and ordnance fields is presented in Catalog 5001C. Equipment covered includes power packages, servo valves and systems, vane pumps, piston pumps, pressure controls, flow controls, directional controls, control assemblies, hydraulic motors, adjustable-speed drives, hydraulic cylinders, and accessories. Each family of products is described in a separate section keyed alphabetically for easy reference. Photographs, drawings, tables, curves, and typical circuit diagrams are included. 74 pages. Vickers Inc., Div., Sperry Rand Corp., Detroit 32, Mich.

Circle 736 on Page 19

Custom Cams

New data sheet provides information on how to obtain continuously generated, mathematically accurate cams through a new method. First page outlines the advantages of the facility. Following this are pictured various blanks, from which one chooses the appropriate blank, and finally, examples of completed cams. 5 pages. Stelron Cam Co., P. O. Box 418, Paramus, N. J.

Circle 737 on Page 19

Mechanical Shaft Seals

Bulletin SS-607 includes specifications, data, and illustrations of a complete line of mechanical shaft seals for the rotating shafts of industrial equipment. Installation pictures show the various seal models in use, and a chart gives complete shaft seal size range. 4 pages. Syntron Co., 260 Lexington Ave., Homer City, Pa.

Circle 738 on Page 19

Damped Structures

Bulletin 60-10 provides information on Rigidamp, a combination of viscoelastic damping materials and rigid structural materials to produce rigid, highly damped structures. Material is included on what Rigidamp structures do, how they work, where they are needed, and how they are used. Pictures and graphs provide many details. 6 pages. Barry Controls Inc., 700 Pleasant St., Watertown 12, Mass.

Circle 739 on Page 19

Noise-Control Products

Engineering specifications and performance data for 27 types of products for the control and measurement of machinery vibration, shock, and noise are provided in Bulletin K4G. Actual installation photographs show a variety of equipment and tell how typical problems were solved. Detailed discussion of the relative merits of steel springs and organic materials as isolation media is included. Easy-to-read selector chart, covering a wide range of equipment, shows recommended and alternate methods of isolation. 8 pages. Korfund Co. Inc., 19D Cantiague Rd., Westbury, L. I., N. Y.

Circle 740 on Page 19

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General Purpose Relays

MEASURE ONLY: 1½" x 1½" x 1%"

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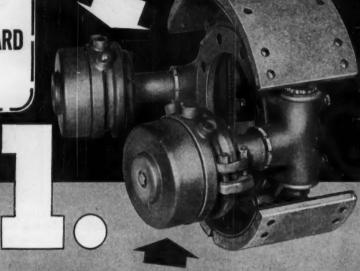
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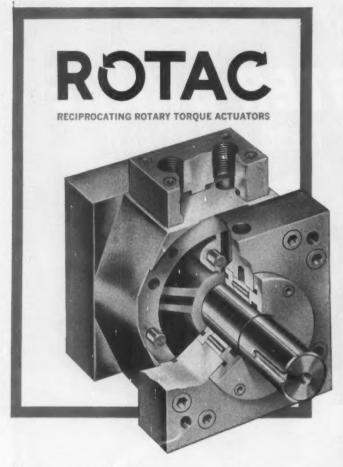
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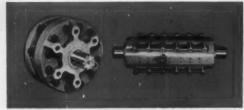
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Large illustration shows construction of Model RN (roller bearing) Rotac. Above is a journal bearing type, Model HN. The special Rotac Reciprocating Torque Actuator at right delivers 1,400,000 in./lbs. torque at 1,000 psi.

Power provided to lift, lower, turn, rotate, index, clamp, toggle, transfer, press, load, unload, turnover or oscillate.

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Power engineered for the heaviest industrial applications or the lightest, most precise uses. Standard units as small as $6'' \times 4^3\!\!\!/_4''$ (round body) or $6^1\!\!\!/_2'' \times 4^1\!\!\!/_4''$ (square body).

Power designed into 26 cataloged models, with over 300 "standard modifications" to meet your needs in size, torque, load, travel, operating temperature or pressure. (Engineering service available for unusual applications.)

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EX-CELL-O

Greenville Plant, 945 E. Sater St., Greenville, Dhio

Tantalum-Foil Capacitors

Bulletin 152G describes expanded line of Tan-O-Mite plain and etched tantalumfoil electrolytic capacitors. Line includes all five case sizes listed in military specification MIL-C-3965B for Styles CL24, 25, 34, and 35. A handy scale simplifies conversion from equivalent series resistance to power factor or dissipation factor, or vice versa. 4 pages. Ohmite Mfg. Co., 3699 Howard St., Skokie, Ill.

Circle 741 on Page 19

Silicone Rubber Insulation

Reliability, versatility, and long life are the outstanding characteristics of wire and cable insulated with Silastic silicone rubber, according to descriptive manual Form 9-114. Using data charts and graphs, brochure explains why the insulated wire and cable has much greater load-carrying capacity. A variety of existing applications for the protected wire and cable are pictured. 6 pages. Dow Corning Corp., Midland, Mich.

Circle 742 on Page 19

General Plate Products

Revised Brochure, "General Plate Products," describes solid and clad base metals, solid and clad precious metals, thermostat metals, and electrical contacts. It also provides information on manganese age-hardening alloys, cored and clad wires, thin-gage metals, solid and clad reactor metals, clad metals for semiconductor applications, and aluminum-iron alloys. Photographs of the items are provided. 14 pages. Metals & Controls Div., Texas Instruments Inc., 34 Forest St., Attleboro, Mass.

Circle 743 on Page 19

Pump Motors

Two types of motors, both applicable to pumps, are illustrated in a new brochure. Cutaway photographs and text describe the features of the two units, available in $\frac{1}{3}$ to 2 hp in single and three-phase types. Tables and engineering drawings provide all dimensional data. 6 pages. Franklin Electric Co. Inc., Bluffton, Ind.

Circle 744 on Page 19

Copying Machine

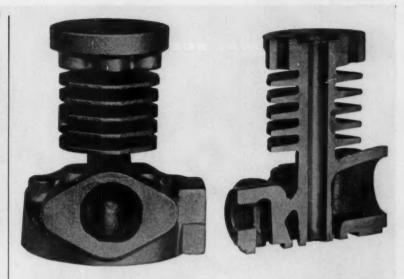
Ditto Masterfax is described in new bulletin. Unit makes spirit master in 15 seconds without typing, offset masters for long runs, high-quality facsimile copies at low cost, and laminates papers. List of applications is provided, and advantages are pointed out. 8 pages. Ditto Inc., 6800 McCormick Rd., Chicago 45, Ill.

Circle 745 on Page 19

Gate Valve

Two-color Circular 610 describes new Union Bonnet bronze gate valve. Sectional views detail the features of the valve, and table of dimensions is also included. 4 pages. Lunkenheimer Co., Cincinnati 14, Ohio.

Circle 746 on Page 19



PRESSURE

A CASE IN POINT—This 8 pound Mechanite Metal casting made for the Joy Manufacturing Co. by Hamilton Foundry is a fourth stage air compressor cylinder. Pressures build up to 6,000 p.s.i. and require a high strength, pressure tight and wear resisting casting. Alloyed Mechanite[®] oil quenched and tempered, raised Brinell hardness of the cylinder wall to 275-300, and increased tensile strength to 60,000 p.s.i. Mechanite was chosen for this casting because controlled structure and small uniform flake graphite produce pressure tight castings of uniform density and strength.

Meehanite is both an iron—and a controlled process. Through the Meehanite Process the microstructure and the quantity and form of graphite is consistently controlled. This means that a specific type of Meehanite can be selected to meet engineered casting requirements. Testing of every ladle of molten iron insures that specifications will be met in the casting.

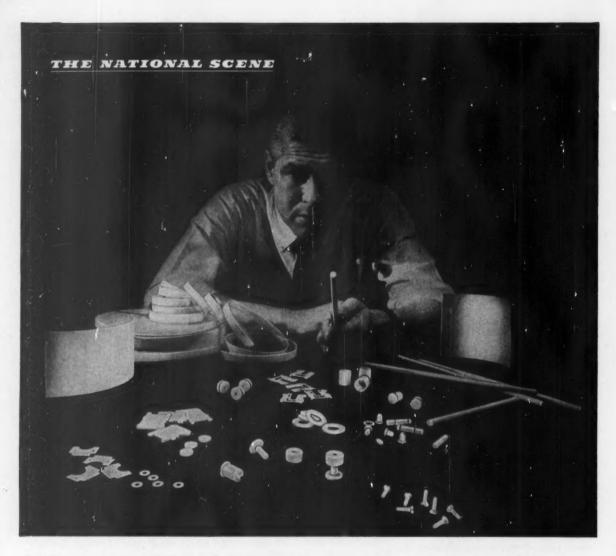
When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules—will be met.

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Polyester Glass Mat: 4 standard sheet grades; custom molded shapes.

PHENOLITE Copper-Clad Laminates: 10 standard grades.

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Subminiature Switches

Catalog 20-1 contains complete information on an expanded line of subminiature switches. Listings include high-temperature, sealed, environment-free, and MIL-Specification switches, as well as phenolic-cased, pushbutton, toggle, and integral-actuator subminiature units. Information also includes five different terminal styles and a variety of switchactuator combinations. Pictorial index shows location of dimensional drawings, descriptions, force and movement speci-fications, electrical ratings, and photo-graph for each switch listed. Information on choice of switches is also included. 16 pages. Unimax Switch Div., W. L. Maxson Corp., Ives Road, Wallingford, Conn

Circle 747 on Page 19

Ball-Bearing Units

Complete line of high-quality ballbearing units is presented in Catalog 454. Literature features comprehensive technical and engineering data, specifications, diagrams, illustrations, and typical applications of Sealmaster ball bearings. 64 pages. Sealmaster Bearing Div., Stephens-Adamson Mfg. Co., Ridgeway Avenue, Aurora, Ill.

Circle 748 on Page 19

Drafting-Instrument Cases

Catalog 60-IC contains information on various combinations of drawing instruments and cases available. They vary from a simple compass and ruling pen in a plastic box to elaborate compass assortments, friction dividers, and ruling pen and beam-compass sets in custom cases. Illustrations of the assortments are also included. 6 pages. V & E Mfg. Co., 766 S. Fair Oaks Ave., Pasadena, Calif. Circle 749 on Page 19

Bimetal Thermostats

Bulletin 8400 covers all main types of bimetal thermostats in the Stemco line. Catalog pictures each of the major thermostat groups, and gives technical, specification, and performance data for both semienclosed and hermetically sealed styles. Reverse side of bulletin includes a chart for converting Centigrade and Fahrenheit temperature scales. 4 pages. Stevens Mfg. Co. Inc., P. O. Box 1007, Mansfield, Ohio.

Circle 750 on Page 19

Super-Alloy Steels

Technical data book supplies the latest factual data on vacuum melting, advantages of metals produced by the consumable-electrode method, and properties of alloys made by the Midvac process. Booklet lists ten improvements possible with vacuum melting of superalloys, high-strength alloys, roll and bearing steels. Analyses, properties, and applications are given for several super alloys and highstrength steels. 20 pages. Midvale-Hep-penstall Co., Dept. MV, Nicetown, Philadelphia, Pa.

Circle 751 on Page 19



Eastman 910 Adhesive solves another production bottleneck

Atkins & Merrill, Inc., industrial model makers, of South Sudbury, Massachusetts, produce quarter-scale cut-away models of the famous Pratt & Whitney J-57 TurboWasp jet aircraft engine.

· Highly detailed, the model contains several compressor and turbine rotors, driven by concealed motors. More than 1,600 small die cast zinc alloy blades are attached to zinc alloy rotors.

Fastening the blades posed a problem, however, as soldering or welding generated excessive heat, causing the blades to warp.

The problem was solved with highstrength Eastman 910 Adhesive. It sets quickly without heat, requires only contact pressure. To date, more than 70,000 blades have been bonded.

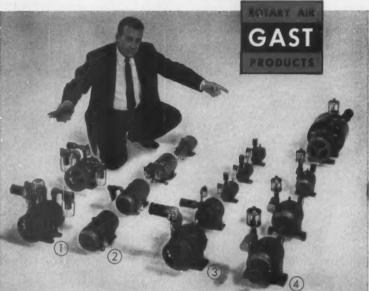
Eastman 910 Adhesive is making possible faster, more economical assemblyline operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heatsensitive elements.

Eastman 910 Adhesive is used as it comes. No mixing, no heating. Simply spread the adhesive into a thin film between two surfaces. Light manual pressure triggers setting. With most materials, strong bonds are made within minutes

What production or design problems can this unique adhesive solve for you?



For a trial quantity (1/3-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9110 Dean Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. M-10, Kingsport, Tenn. (Not for drug use) See Sweet's 1960 Prod. Des. File, 7/E



"Choose from this wide range of Gast Air Compressors", says C. E. Bradley, Ass't. Sales Mgr. "Vacuum Pumps are also available in corresponding models."

Here's high performance . . . in a full line of

GAST COMPRESSORS and VACUUM PUMPS

When you select original equipment Air Pumps, look at the Gast Line. You'll see how your product—and budget—may benefit.

Within a well-defined range, Gast Pumps excel on hundreds of product applications. (Capacities .6 to 45 cfm.; pressures to 30 psi., vacuum to 28 in. Hg.) Precision-built primarily for O.E.M. use, they are rugged and dependable. Simple rotary-vane design maintains like-new performance for years, because vanes take up their own wear automatically. Air displacement is positive and pulseless-no air tank needed. Ball bearings and self-adjusting shaft seals keep efficiency high. Types include: Dual-chamber (one chamber for vacuum, one for pressure), integral-motor pumps, light-duty models for moderate pressure or vacuum, and fan-cooled models for heavy-duty service. Oil-less (carbon-vane) types provide absolutely oil-free air if desired.

Submit your problem for suggestions by Gast Engineers-or . . .

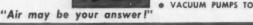
Write today for Catalog on Compressors or Vacuum Pumps. State specific type or capacity that interests you.

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(Front to rear) Dual Chamber Pumps:	Integral-Motor Pumps for O.E.M. or Lab use:	Light-Duty Models Moderate Vac./Press.	Heavy-Duty Models, with Fan Cooling, V-belt or Direct Dr.
Model 11 x 1740,	0521, 1/3 hp. to 3.8 cfm.	3040, up to 24.2 cfm.	Y-bell or birect by.
total to 23 cfm.	0321, 1/4 hp. to 2.2 cfm.	1550, up to 15.0 cfm.	2565, to 21.0 cfm.
10 x 1040, to 18 cfm.	0211, 1/6 hp. to 1.3 cfm.	0740, up to 5.6 cfm. 0440, up to 4.0 cfm.	1065, to 8.3 cfm. 0465, to 4.0 cfm.
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- AIR MOTORS TO 7 HP COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.





HELPFUL LITERATURE

Electrical Connectors

Pipeline Strainers

Colorful Bulletin PR259-1 includes technical information, ratings, and outline dimensions on new single-conductor plugs and receptacles, Supercon electrical connectors. Pictures, tables, drawings, and diagrams provide technical information. Bulletin describes all 25, 50, 100, and 250-amp types available. 12 pages. Superior Electric Co., Dept. SPR, 83 Laurel St., Bristol, Conn.

Circle 752 on Page 19

Four basic types of pipeline strainers for condensate, steam, water, oil, air, gas, and other piped fluids are covered in Bulletin 1210. It details construction and operating features of a range of Y-type strainers which protect steam traps, pumps, control valves, and compressors against dirt, scale, or metal chips. New Type CT cast-steel strainer for pressures to 600 psi is a feature of the bulletin. 4 pages. Sarco Co. Inc., 635 Madison Ave., New York 22, N. Y.

Circle 753 on Page 19

Bolts and Nuts

New family of superbolts and companion locknuts for applications to 900 F is described in two new bulletins. Literature gives complete specification information, and reviews processing techniques used to manufacture the fasteners, weight-saving possibilities in design, and general areas of application. Bolt bul-letin is designated EWB929, and nut bulletin, FN 926. 4 pages each. Standard Pressed Steel Co., Box 102, Jenkintown,

Circle 754 on Page 19

Solid-Film Lubricant

Surf-Kote A-1290 air-drying, solid-film lubricant is described in a new bulletin. Bulletin provides information on application and surface preparation. It also includes a table of physical properties. 2 pages. Hohman Plating & Mfg. Co. Inc., 814 Vermont Ave., Dayton 4, Ohio. Circle 755 on Page 19

Differential Transformers

General Catalog 100B contains information on various types of transducers, transducer accessories, and differential transformer instruments. Units are pictured, and features are pointed out. Specifications and application notes are provided for each unit. 16 pages. Daytronic Corp., 223-227 S. Jefferson St., Dayton 2, Ohio.

Circle 756 on Page 19

Hydraulic Equipment

Condensed catalog EJS contains information on machine tool and industrial hydraulies, including application recommendations. Many photographs and tables provide dimensions and specifications. 8 pages. John S. Barnes Corp., 315 S. Madison St., Rockford, Ill.

Circle 757 on Page 19

Epoxy-Insulated Motors

New four-color bulletin, PB 6000-12, describes Crocker-Wheeler epoxy-insulated motors to 500 hp, Class B, 60 C rise, random wound in voltages to 600 and form wound in voltages to 4160. Detailed illustrations and cutaways of coil slots, stator and rotor laminations, finished coils, entire wound stator, and assembled core and frame show how the epoxy insulation completely fills slots and penetrates coils. 4 pages. Elliott Co., Jeannette, Pa.

Circle 758 on Page 19

Semiconductor Products

Four-color, condensed catalog describes a complete line of industrial and military semiconductor products. Brochure lists key specifications of the products including germanium power transistors, audio and switching transistors, silicon and germanium mesa transistors, silicon rectifiers, and silicon zener diodes, 12 pages. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Ariz.

Circle 759 on Page 19

Teflon and Kel-F

Bulletin P-103 on porous Teflon and porous Kel-F lists standard forms, such as discs and sheets, which are fabricated from these chemically inert filter media. Complete specifications of standard materials include: Porosity, mechanical properties, chemical resistance, flow capacity, and standard thicknesses. Bulletin lists standard disc and sheet sizes, including prices. 4 pages. Porous Plastic Filter Co. Inc., 30 Sea Cliff Ave., Glen Cove, N. Y. Circle 760 on Page 19

Packings

Bulletin provides data on Vim leather and Vix-Syn synthetic rubber packings. Various types of units are pictured, and dimensional data are provided in tables and cross-sectional drawings. 4 pages. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Circle 761 on Page 19

Steel Pipe and Tubing

Bulletin T467 provides information on Croloy steel pipe and tubing for high-temperature service. Technical data are furnished in the form of a three-page table giving properties of 13 Croloy steels, and also of carbon and carbon-molybdenum steel. 6 pages. Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 762 on Page 19

Instrument Cases

Comprehensive line of instrument cases is described in pocket-sized Brochure 403-G. Booklet gives full details on features, sizes, colors, and standard hardware that can be obtained when ordering the predesigned cases. 12 pages. TA Mfg. Corp., 4607 Anger St., Los Angeles 39, Calif.

Circle 763 on Page 19



- * 360° adjustment
- * patented locking ring assembly-will not work loose
- ★ concentric grooves all MVP sheaves are finish-grooved after assembly, providing excellent concentricity and uniform pitch diameters, insuring a true running sheave
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Computer-Grade Capacitors

Bulletin GEA-6819B describes high-quality computer-grade Alumalytic capacitors for power supply in military and commercial computers. Publication gives electrical characteristics, ratings, life-test data, and dimensions, including corresponding bracket configurations. Bulletin outlines manufacturing procedures and process controls which assure high standards for quality and reliability. 4 pages. General Electric Co., Schencetady 5, N. Y. Circle 764 on Page 19

Electronic Switches

Data Sheet 177 describes bounce-free electronic switches that eliminate spurious voltage pulses caused by contact bounce. Information is given for types available, temperature range, characteristics, and mounting dimensions. 2 pages. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 765 on Page 19

Magnetic Starters

Brochure 14-B2 describes new magnetic starters featuring unitized construction with all components front removable. Specifications and all information are provided in exploded view, tables, dimensional drawings, and text. 4 pages. Furnas Electric Co., 1045 McKee St., Batavia. III.

Circle 766 on Page 19

High-Vacuum Gages

Bulletin 9/1 pictures and describes a line of manometers, thermal gages, ionization gages, magnetic-amplifier controllers, and sensing tubes. Advantages and features of the various units are presented, along with information on specifications 32 pages. Consolidated Vacuum Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y. Circle 767 on Page 19

Nodular Iron

Bulletin 47 provides specifications for five different types of Meehanite nodular iron. Included in the illustrated presentation are many examples of castings made of this metal. The S-types of the metal are described in detail. Tables give specifications, and other information includes toughness, compressive strength, modulus of elasticity, fatigue resistance, and machinability. 8 pages. Write on company letterhead to Meehanite Metal Corp., 714 North Ave., New Rochelle, N. Y.

Permanent Magnets

Permanent looseleaf catalog listing stock permanent magnets is now available. Catalog incorporates all characteristics of new designs in multiple casts, blocks, bars, cylinders (solid and hollow), salient pole (internal and external radii), curved path, and Genox (ceramics) permanent magnets. Application data are given for the various types of magnets. 50 pages. Write on company letterhead to Applications Research Div., General Magnetic Corp., 10001 Erwin Ave., Detroit 34, Mich.



These spray nozzles for highway striping paint sprayers were formerly machined out of cold rolled bar stock. When ordinary paint was used, these nozzles functioned satisfactorily. However, when ground glass was added to the paint for reflecting purposes excessive wear caused frequent replace-

By "the HITCHINER way . . .", we were able to engineer the manufacture of this part by investment casting in a non-machinable type alloy exhibiting a very high degree of resistance to both wear and corrosion.

This change of alloy, which eliminated the need for frequent nozzle replacement, was made possible through investment casting because the required close dimensional tolerances and detail could be cast to size.

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under wide variances in temperature ranges. Aero Bolt & Screw Co., 1071 W. Arbor Vitae, Inglewood, Calif.

Circle 768 on Page 19

Precision Spur Gears

in sizes from 1/10 to $2\frac{1}{4}$ in. OD

Fine-pitch precision spur gears are available in standard sizes from 48 to 120 diametral pitch—10 to 40 teeth in stainless steel and 42 to 180 teeth in aluminum. Each gear is AGMA Precision Class 1 or better, and all materials and protective finishes conform to federal and military specifications. Small gears, ranging from 1/10 to 2½ in. OD, are used in instruments, meters and controls, and in precision components for aircraft and missiles, com-



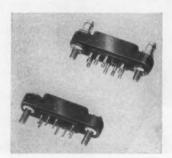
puters, communications apparatus, and similar electromechanical equipment. Boston Gear Works, Quincy 71, Mass.

Circle 769 on Page 19

Miniature Relay Sockets

are rectangular, eight-contact units

Microminiature rectangular relay socket connectors are for use with plug-in relays in a variety of electronic circuit applications requiring ease of maintenance and assembly. Designated Series 145-8, the eightcontact units measure 111/32-in. long and are available with solder cup for direct wiring or dip-solder pin termination for printed-circuit assembly. Relays with mounting flange can be attached to the mounting studs of the connector for protection against danger of sudden disconnect. A polarizing hole in the face of the molding eliminates possibility of inserting relay incorrectly. Two mounting styles permit top chassis mounting and mounting on



either side of panel or chassis. Electronics Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City I, N. Y.

Circle 770 on Page 19

Ball-Bearing Mounts

can be mounted directly onto thin plates

Preassembled ball-bearing mounts can be mounted directly onto thin plates without costly screw-machine parts or time-consuming assembly procedures. Barrel mount is supplied with external retaining rings, one bowed and one straight, for either 1/16 or ½-in. thick plates. Assemblies are normally supplied with ABEC-1 or equivalent bear-



ings. Bore sizes are ½, 3/16, and ¼ in. Precision Specialties Inc., Box 118, Pitman, N. J.

Dry Lubricant

has extremely low coefficient of friction

Dry, greaseless lubricant, Poly-Powder, can be sprayed onto sliding surfaces or moving parts. The white, sanitary powder is manufactured from pure Teflon. It is completely odorless, colorless, tasteless, and nonstaining, and has the lowest coefficient of friction of any solid material—0.016 to 0.024 in. against pol-

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Heaters available in shapes, sizes and wattages to fit hundreds of industrial heating needs . . . including yours. Installation is quick and easy . . . using standard bolts or clamps. Heaters give long service with little or no maintenance. Temperatures are maintained by either manual or automatic controls.

Write for Bulletin PA100. Or, for fast action and on-the-job assistance with your heating problems, call your Chromalox Sales Engineering Representative listed below.

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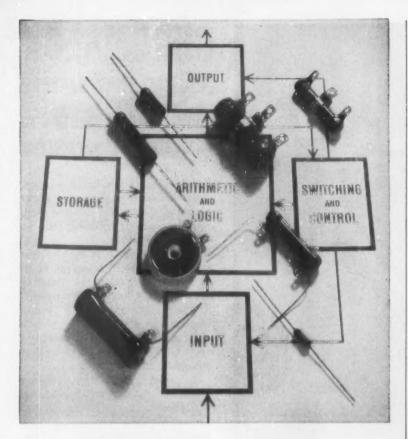
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If you want maximum quality and maximum reliability in your product, follow the lead of outstanding digital computer manufacturers—like IBM, Remington Rand, and Burroughs—and specify W/L VITROHMS. You'll find full information in catalog D130. Write for your copy, and the name of your nearest VITROHM distributor, today. Ward Leonard Electric Co., 58 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)



DESILIT-ENGINEEPED CONTROLS SINCE 189

WARD LEONARD

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ished-steel surface. Operating temperature range is -450 to +400 F. Lubricant can be used on wood, metal, rubber, plastics, leather, glass, and many other materials over very broad operating conditions. It can be added to liquid and grease-type lubricants to increase lubricity characteristics. Polydoris Products Corp., 5306 W. Lawrence Ave., Chicago 30, Ill.

Circle 772 on Page 19

Ball Screws and Splines

are available in a range of sizes

Standard ball-screw and ball-spline assemblies are less precision-type units which provide efficient but less costly actuation. Applications lie principally in the moving of loads with low breakaway friction, in minimum space requirements and low service requirements result-



ing from minimized friction and wear. Cutaway nut shows how balls recirculate to provide antifriction contact medium between nut and screw. Beaver Precision Products Inc., Clawson, Mich.

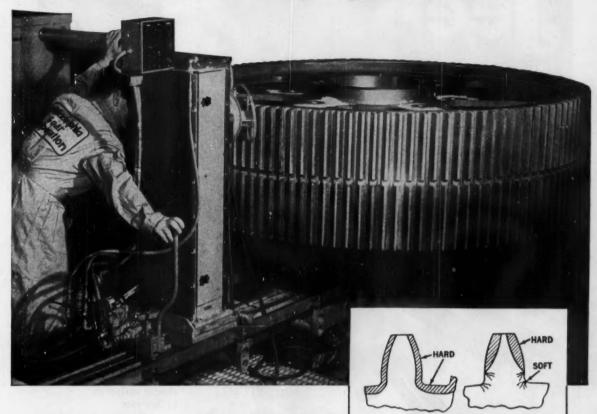
Circle 773 on Page 19

Plastic Grommet

two-piece unit is inserted and snapped together

Wire, cable, or tubing can be insulated and supported from a mounting panel, chassis, wall, housing, or similar surface with a new plastic grommet. Grommet, which has two identical halves, is inserted in panel hole and snapped together. It locks in place and provides a rigid bearing surface, greater dielectric and extreme chemical and wear resistance. Any color and any plastic material can be used for color coding or special applications. Three sizes available have hole diameters of 3/16, ½, and ¾ in. Panel hole

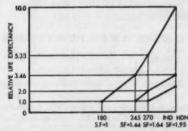
New Philadelphia induction hardening increases life of large gear drives . . .



HERE'S WHY: Full tooth contour induction hardening of large gears provides a uniformly hardened surface from one tooth flank around the root and up the other flank without interruption. Eliminates points of thermal stress concentration. And there is no distortion, a problem of heat treated gearing that requires subsequent grinding.

This new, advanced Philadelphia method permits radical reduction in sizing and/or increased load carrying capacities. And it can easily harden even the largest spur, helical and herringbone gearing up to 180 inches in diameter, 20 inches in face, and 3/4DP.

Learn more about this new method for increasing the service life of your gear drives. Write for your copy of Bulletin 100. New Philadelphia full contour induction hardening (left) provides a continuous hardened area from one tooth flank around the root and up the other flank without interruption. There are no points of stress. Typical heat treated gear (right) shows inadequate hardening of root of tooth, a point of major stress.



This chart shows the relationship between load and gear life. Note that the improved service factor of a gear set may be used to substantially increase gear life, rather than to increase the load.

phillie gear

PHILADELPHIA GEAR CORPORATION

King of Prussia (Suburban Philadelphia), Pennsylvania





required is 1/8 in. larger than wirehole diameter. Budwig Mfg. Co., P. O. Box 4212, Glendale 2, Calif.

Circle 774 on Page 19

Stainless-Steel Wire

is brass plated

Stainless-steel wire with electroplated brass finish combines the good adhesion of brass to rubber with the corrosion resistance of stainless. Initial applications are expected in high-pressure hose and in timing belts. Electroplated brass finish is available on all common types of stainless wire ranging from 0.007 to 0.103 in. diam. National Standard Co., Niles, Mich.

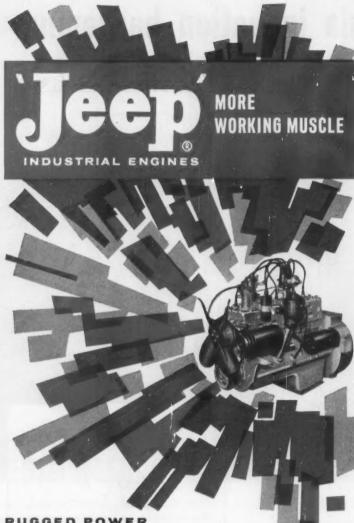
Circle 775 on Page 19

Flow Switch

detects variations in flow rate

FS-400 flow switch detects variations in the flow rate of fluids or gases for a positive indication. Unit can operate a remotely located warning light or other indicator, visual or audio. Automatic interlocks or pump motors can be actuated through suitable relays. Displacement of the magnet-equipped shuttle by a fluid or gas actuates the hermetically sealed switch contacts within the bronze stem. Bypass holes in the shuttle skirt permit





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... including positive valve rotators, valve inserts, Stellite or Eatonite valves and more, at no extra cost.

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America's only "F" head design. Gives extra pow-er, efficiency, economy! Max. BHP, 70 Max. Torque, 111 ft. lbs.

'Jeep' 4-L, 4 cylinder

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Max. Torque, 106 ft. lbs.

'Jeep' 6, 6 cylinder

High torque maintained throughout continuous speed range. Excellent heavy duty performer.

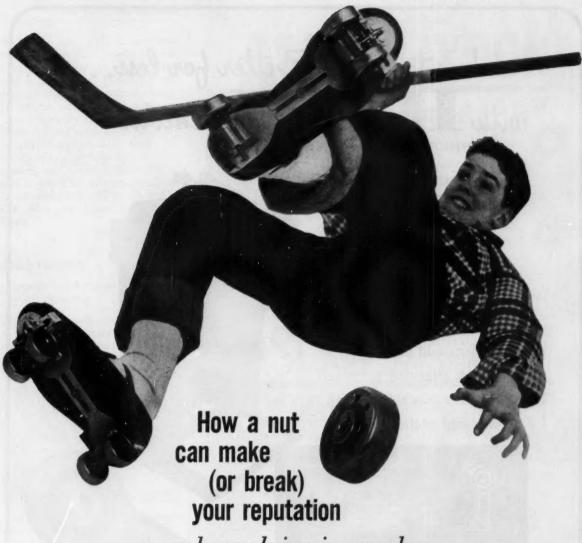
Max. BHP, 92 Max. Torque, 180 ft. lbs.



Write for power curves, engine details, prices

WILLYS MOTORS, INC. MOTORS Industrial Engine Dept., Toledo, Ohio

Manufacturers of -4 and -6 Cylinder Industral Engines



... and even bring in re-orders

A nut comes loose. A wheel comes off. And down comes Billy! No great loss, except perhaps to his dignity. But when a lost nut knocks out a rock drill, or a tractor, or a piece of the heavy equipment that you make—then what?

Down goes the machine! Down goes production for no telling how long! And down goes your reputation as a maker of quality equipment! You can blame it on the put, but your customer blames you!

it on the nut, but your customer blames youl
This kind of embarrassing and costly "Reliability"
failure simply cannot occur when you specify Elastic
Stop® nuts for critical bolted connections. For no
matter how rugged or repeated the shock or impact,
no matter how bone-shaking or constant the vibra-

tion . . . Elastic Stop nuts simply will not work loose!

Elastic Stop nuts with their exclusive, vibration-damping nylon locking inserts are nothing new. They have been widely used for over 20 years by an increasingly large number of quality-conscious manufacturers who have learned that Elastic Stop nuts give built-in insurance against product failure—the kind of reliability that shows up in customer maintenance records and adds up to reorders. Let us send you information showing how manufacturers have protected the reputation of their products with Elastic Stop nuts. Ask for Bulletin 5901. Dept. S47-104 Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.



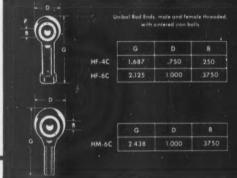
for the ring reliability

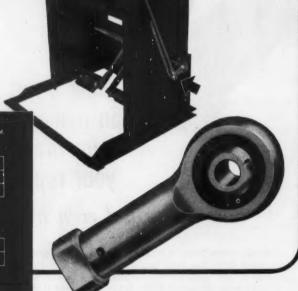
ELASTIC STOP NUT CORPORATION OF AMERICA

How to do it Better for less... with HEIN Unibal®

SPHERICAL BEARING ROD ENDS

This is the Collar Shaping and Pressing Machine made by the Reece Folding Machine Company, which is a low-priced, manually operated device used in the shirt trade for shaping and pressing collars after they are sewed together, but before being attached to the shirt.





Unibal Rod Ends are used in five places, and were chosen for some carefully-thought-out reasons.

- Unibal ball joints lower the machining and assembly cost. A male Unibal is used at the fulcrum of the triangular pressing lever at top center. This allows the pressing plates to be easily lined up with the mating surface without expensive machining to close tolerances.
- Long wearing qualities reduce replacement costs.
 Reece says, "We have been using Unibal rod ends in our machines since 1947, and as far as we know, none have had to be replaced because of wear.
- Solve design problems economically. The use of Unibal "gets us out of some tough design problems quite economically, simplifies co-operating parts and makes final assembly easier."
- Maintain easy, smooth action. Heim Unibal rod ends are used to transmit motion from the lower shaft to the pressing plates between levers moving in arcs in different planes. They maintain the easy action necessary to manual operation.
- · Correct misalignment in all directions.

The high quality and special advantages of Unibal Spherical Bearings and Rod Ends can save you time and money in the assembly of your machines. Ask our engineering department how. Send for the Heim complete catalog.

THE HEIM COMPANY Fairfield, Connecticut

ALL HEIM BEARINGS ARE AVAILABLE THROUGH THE LEADING BEARING DISTRIBUTORS IN THE U. S. AND CANADA

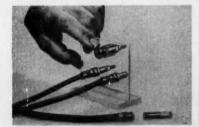
maximum flow with a minimum pressure drop. Completely dependable and precise in repeatability, unit is low enough in cost for economical large-system quantity usage. It can be calibrated for actuation in any position, and can be applied in almost any application requiring a reliable indication of flow. Installation is extremely simple. Unit replaces any standard elbow fitting and is available in port sizes from 3/4 through 2 in. NPT. Gems Co. Inc., Sheppard Lane, Farmington, Conn.

Circle 776 on Page 19

Quick Connects

provide rapid changes of air circuiting

Flexibility for making quick changes in air circuitry is possible through two new styles of miniature panel mounting quick connects. Shown in the photo are several of the units,



available in various port arrangements and sizes. Clippard Instrument Laboratory, 7390 Colerain Rd., Cincinnati 39, Ohio.

Circle 777 on Page 19

Conductive Gasketing

for high-temperature uses

Cohrlastic conductive gasketing is a silicone rubber and metal material which conforms easily to irregular surfaces and is impervious to fluids. It is available specifically for hightemperature use. Gasketing is available in two types, No. 8516 and No. 8520, which are 30 and 24-mesh aluminum-alloy wire-cloth, impregnated with a 50-durometer silicone rubber to a thickness of 0.016 and 0.020 in. Construction provides a material which withstands temperatures from -65 to +500 F. Gasketing is recommended for use where a necessary conductive material is needed between two metal surfaces



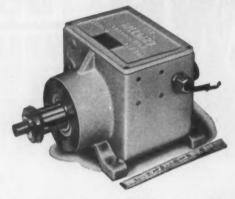
MIRROR IMAGE ON BOTH COASTS EAST ELECTRICAL TIMING DEVICES WATERBURY, CONNECTICUT

ELECTRONIC TIMING DEVICES WEST CULVER CITY, CALIFORNIA

Have it your way: electronic or electro-mechanical timing devices and test equipment. ■ The A. W. Haydon Company will design and manufacture either type...or both...to your rigid specifications. And with the same precision, compactness and high reliability as always. ■ For electro-mechanical devices call on our timing specialists at Waterbury, Conn. If your requirements are electronic, our Culver City, Calif. plant can meet your needs. ■ On either coast...on both coasts... there's only one A. W. Haydon.



RD'S. /Verre"L.D.U."



A complete, packaged unit that gives you precise control of intermittent motion from a constant rotary power source!

Built-in features:

- Contains all the parts in one package.
- Can be installed as easily as a motor and needs only electrical connection.
- Self-lubricating for long life of 40,000,000 or more cycles.
- Operating speed from 40 to 400 R.P.M.
- Torque capacity 36 ft. lbs.
- No cumulative error in cycling.
- Instant engagement.
- Mount with direct coupling connection or use with belt, chain or gear drive.

Can be installed on existing equipment, designed into new machinery and re-used after production line changes.

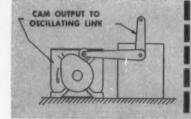
A single package unit that gives you precise control of intermittent motions . . . oscillate or repeat . . . clip and bend . . . shear or slash . . . raise or lower . . . index and position . . . from a constantly rotating source

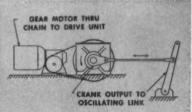
HILLIARD "I.D.U." eliminates the need of buying separate parts and assembling a "custom" machine with assorted mechanisms

to control it.
"I.D.U." features highly flexible control manual, mechanical or electrical—permitting "demand" type operations in fixed or variable cycles. A protected drive, totally enclosed in an oil bath housing, it is ideal for dusty, "steamed" or "washdown" conditions.

Write on your letterhead stating your intermittent motion problems and we will provide complete information.

Typical intermittent controls by "I.D.U"





Basic Unit Price \$289.00

Optional accessories extra

the HILLIARD Corporation

103 W. FOURTH ST. ELMIRA, NEW YORK

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

NEW PARTS AND MATERIALS



to allow the flow of electrical current while restricting or filtering any induced radio frequency. Connecticut Hard Rubber Co., 407 East St., New Haven, Conn.

Circle 778 on Page 19

Germanium Transistors

15-amp units have low silhouette

New 15-amp germanium industrial-power transistors in an improved low-silhouette TO-36 (doorknob) package have a 150-w rat-Package features a design which requires 30 per cent less headroom than other doorknob de-Cold-welded sealing techvices. nique prevents any weld flashback from contaminating the transistor junction. Units are rated for 100 C continuous junction operation and dissipate 150 w at 25 C case tem-



perature. Maximum thermal resistance is extremely low. Technical Information Center, Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Ariz.

Circle 779 on Page 19

Spiral Spacer

fastens parts to honeycomb panels

SSP spiral spacer is for use when parts or materials are to be assembled or joined with fasteners to honeycomb panels and other hollow or core-type structures. Spacer

new white-light



stops motion with 7 million candlepower light flash

- * One Microsecond Flash Duration
- * 110 to 25,000 RPM Direct Reading. Useful to at least 250,000 RPM

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Circle 531 on Page 19

VALUE ANALYSIS REVEALS SPECIAL ADVANTAGES OF INTEGRALLY BUILT-IN PUMPS

Designers of machines employing lubricating pumps or low-pressure hydraulic systems can now achieve more compact design and reduced costs by integrating three matched Gerotor pump components directly into their mechanism. This space-saving innovation is now widely specified for machine tool, automotive, aircraft and other fluid systems.



Fig. 1, Three Geroter components permit pump to be incorporated as integral part of housing of frame of mechanism, eliminate need for purchase and meruling of separate, complete pump.

and mounting of separate, complete pump. A three-piece insert package makes this economical pump integration possible. Consisting of an inner and outer Gerotor and an eccentric locator-ring, the unit becomes a complete pump by simply boring the easting or frame of the mechanism to accommodate the locator ring O D, and by providing porting. This design makes the main casting do double duty as the pump housing, thus eliminating a very considerable cost factor. A drive can be taken from any convenient shaft. A simple, positive-acting automatic reversing feature can be built in at little cost.

► The Gerotor is a form of internal gear pump consisting of only two moving parts: an inner toothed element and an outer, meshing toothed element. The inner element has one less tooth than the outer and the "missing



tooth" provides a chamber to move the fluid from the inlet port to the outlet. (See Figure 2). Pump capacity is measured by the volume of the "missing tooth" multiplied by the number of driver teeth and RPM.

FIG. 2 teeth and RFM.

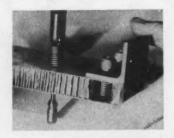
The designer thus has the advantage of several variables to secure a given capacity within his space limitations: Gerotor diameter — which governs the area of the pumping chamber — Gerotor thickness which, taken with area, determines chamber volume — Gerotor RPM, since this is a positive displacement pump. Thus, it is possible to vary the diameter, the length and the speed of the pump within certain overall limits to secure the wanted capacity.

W. H. NICHOLS CO.

Makers of Zenith Metering Pumps and the Nichols Milling Machine "the miller that uses its head".

48 WOERD AVE., WALTHAM 54, MASS.

NEW PARTS AND MATERIALS



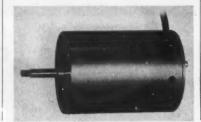
is a universal type easily installed with inexpensive hand tools. It is available in any desired length for use with 3/16, 1/4, 5/16, and 3/8in. diam rivets, bolts, or Huckbolt Spiral design and infasteners. stallation method permit use of the same hole diameter as that of the fastener. Spacer provides optimum columnar support for panel face sheets, and maximum joint strength. High column strength also avoids crushed or inadvertently dimpled panels. Typical structures and materials for which the spacer-fastener combination is recommended are: Honeycomb panels; metalfaced panels having cores of balsa, styrofoam, or other crushable materials; square tubing; hollow partitions; thin-wall channels; and corrugated sheets. Huck Mig. Co., 2480 Bellevue Ave., Detroit 7, Mich.

Circle 780 on Page 19

Blower Motor

features high speed and low noise

C-20-37 vane-axial blower motor is a ruggedly constructed unit designed to operate without diminished performance even in very severe environments. Special design features include extreme speed, low noise, high efficiency, precision balance, and superior quality. Open-ventilated motor conforms to applicable portions of MIL-M-7969, MIL-S-7742, MIL-E-5272, MIL-E-4970, MPD2063, and MPD154. Unit is





Flexible Couplings





from .003 to 4250 H.P. 1/a In. to over 91/2 In. Bores

- Can be installed in minutes
- Align with a straight edge no gauges required

The most trouble-free couplings you can install on your equipment ... no complicated mechanisms, all parts open for inspection, reversible cushions, no lubrication required. Immediate delivery from stock in any quantity.

Send us your requirements for quick recommendations and prices. Ask about our helpful Flexible Coupling Guide Sheet and request



Catalog C-56.

FIRST NAME IN FLEXIBLE COUPLINGS

LOVEJOY FLEXIBLE COUPLING CO.

4818 West Lake Street, Chicago 44, Illinois Telephone: EStebrook 9-3010 unusual design in upset forging...

BALL-JOINT HOUSING for the steering and driving mechanism of the Clark Equipment Company's line of Four-Wheel Drive MICHIGAN End Loaders and Turbo-Dozers formerly produced as a steel casting is now turned out by Commercial as a closed-die forging on an 8-incl. upsetter.

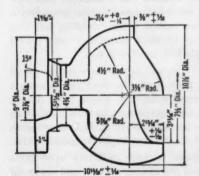


80 lb. forging replaces 95 lb. casting

A saving of 15 lbs. of metal on each housing component is only part of the impressive cost cutting story made possible at Clark Equipment Company by a switch to upset forgings.

When the parts were produced by Commercial as closed-die forgings on an 8-inch upsetter Clark Equipment reported:

- 1. An initial cost saving of 90¢ per part.
- 2. Closer tolerances for a 10% machining cost saving.
- 3. No rejects due to hidden metal defects.



UNUSUAL SHAPE and characteristics notwithstanding—flanged on one end, belled on the other, and open on both ends—Commercial engineers proved this part could be produced as an upset forging with greater cost savings. Now, this important component not only costs Clark less per unit, but because of its controlled grain flow and efficient metal distribution it provides maximum tensile and torsional strength to resist unusual operating strains as well as massive and unpredictable shock and load. Longer operating life and trouble-free performance are assured.

And because forging impact and pressure produces a more dense, more uniform metal structure, forged parts absorb and dissipate heat at a uniform measurable degree. Obviously, that means elimination of distortion problems in heat treating. It also means fewer rejects during machining, since this dense uniform forged metal has no hidden internal flaws.

With new forging techniques continually unfolding to meet specific job requirements, more original equipment manufacturers are increasingly looking to upset forging to help solve their component forming problems—stronger, lighter, more compact parts at less cost per unit.

Many parts like this unusually shaped housing for Clark Equipment, which were formerly considered impossible to forge, are now routine at Commercial. An early check with Commercial's forging engineers on your particular component forming problem may pave the way for improvement in your product design and production methods—could save you time, money, and help improve performance and operating life.

WHEN AN UPSET FORGING?

Check your part forming problems against this list of "bench marks" for parts requiring:

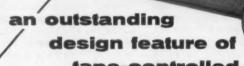
- Reduced weight, thinner section, greater strength.
- Consistent soundness no losses due to porosity.
- Good appearance—smooth, close-grained surface.
- · Superlative shock and fatigue resistance.
- Uniform response to heat treatment.
- Cost-cutting advantages in finishing—less waste metal, reduced machining, no rejects due to hidden flaws.

Address The Commercial Shearing and Stamping Company, Dept. 8-42, Youngstown 1, Ohio.

COMMERCIAL shearing and stamping

Maxitorq

Series 9000 electric clutches and brakes



tape-controlled automatic turret lathes

Five Maxitorq Series 9000 Electric Clutches are used in the all-new Potter & Johnston No. 3E-15 Tape-Controlled Automatic Turret Lathe. Four are used in the headstock to provide automatic spindle speed changes and a fifth is used as a master clutch in the feed drive. These clutches of advanced design have PROVED their ability to assure consistent, positive and extremely fast action; essential to these machines. They transmit full load, are self-compensating for wear and permit great flexibility in control.

With operation induced entirely by magnetic flux, Maxitorq Series 9000 Electric Clutches are well adapted to a wide range of machine tool drives. They are simple and rugged in design, require no adjustments, can be used either as a clutch or brake and are built to American Machine Tool Standards. Disc separators not only separate discs, providing a drag-free neutral without heating, but also break up residual magnetism and permit extremely fast, positive action.

The 9000 Series Clutches have a minimum of moving parts and the electrical operating unit remains stationary, hence, there are no brushes, slip rings or complex wiring. Maxitorq Clutches operate on 110 V. A. C. rectified to 90 V. D. C. Other voltages on special order. If you have a clutch or brake application where you are looking for new and improved performance, bring your problem to us.

Phone, wire or write Dept. MD for Series 9000 Bulletin.

The Carlyle Johnson Machine Company, Manchester, Conn.

3 CJ59

MACHINE DESIGN

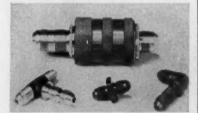
rated ¾ hp, 200 v, 400 cps, 3 phase. Speed is 22,300 rpm, and torque (full load) is 2.83 oz-ft. Weight of motor is 3 lb 10 oz. Kearfott Div., General Precision Inc., 1150 McBride Ave., Little Falls, N. J.

Circle 781 on Page 19

Quick-Disconnect Coupling

for high-pressure systems features push-pull disconnect

Quick-disconnect coupling applicable to gas or fluid systems is a true push-pull, high-pressure quick-disconnect, since only one motion in the direction of fluid flow is necessary for connect or disconnect. Coupling functions properly at 3000-4000 psi operating pressures, with proof pressures of 6000 psi, and



burst pressures of 250 per cent of rated pressures for a minimum of two minutes. It is available in a choice of stainless steel or aluminum. Hydraulic Components Div., Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

Circle 782 on Page 19

Plastic Coatings

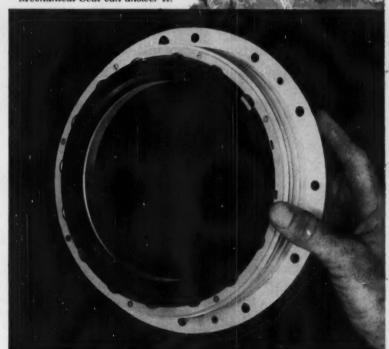
have excellent adhesion and electrical properties

Tough coatings of Vitel polyester plastic resin have exceptional resistance to abrasion, ultraviolet rays, chemicals, and weather. Other advantages include excellent adhesion, clarity, and electrical properties, and the ability to bind pigment. Applications include clear, tinted, or colored coatings for metals and automotive hardware such as bumpers and wheel covers, and as protective and decorative coatings for architectural aluminum and aluminum foil, in wood stains, toners, primers, and finishes. Coatings improve gloss, wet strength, and rate of vapor transmission when applied to paper. Resins have use in hot-melt adhesives and coatings.

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Mechanical Seals

DIVISION OF BORG-WARNER CORPORATION

P.O. Box 2017, Terminal Annex, Los Angeles 54, California

SEE OUR FILE IN SWEETS DESIGN CATALOG - SECTION 8e

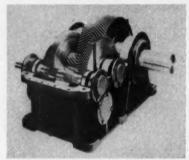
Coatings can be applied by spraying, dipping, roller coating, brushing, hot melt, and knife coating. Chemical Div., Goodyear Tire and Rubber Co., Akron, Ohio.

Speed Reducers

in single, double, and triple-reduction types

Redesigned, expanded line of balanced-design, parallel-shaft speed reducers is available in 57 sizes. Drive selections can be matched closely to horsepower requirements. Single, double, and triple-reduction units are available in capacities to 2800 hp at high or low output

Circle 783 on Page 19



speeds and ratios to 292:1. Shafts can be arranged to suit specific drive requirements. Design permits assembly with single-shaft projections in either direction, or with double-shaft projections. Link-Belt Co., Dept PR, Prudential Plaza, Chicago 1, Ill.

Circle 784 on Page 19

Pushbutton Control Units

have single-circuit contact blocks

Type R pushbutton control units and selector switches feature use of compact, single-circuit contact blocks with convertible contacts. Contact blocks can be mounted in any combination to obtain any contact arrangement required. Convertible terminals can be changed quickly from normally open to normally closed, and vice-versa, without use of additional parts or special tools. Blocks are keyed to insure staggering of terminals when mounted in more than one tier, and up to eight can be combined for use on a single operator. Controls include a wide



Much stronger, they last longer when they're of reinforced TFE*

RULO

Because Dixon's self-lubricating RULON has all the advantages of Teflon (low friction, chemical inertness, zero moisture absorption, extreme temperature range) PLUS a tremendous increase in mechanical strength and wear resistance, this engineered material is a natural for sealing applications. It exhibits no stick-slip characteristics . . . greatly reduces starting torques. And unlike rubber or leather, it retains its original dimensions, maintains positive contact with shafts or cylinder walls, and has infinite shelf life . . . being completely unaffected by weather, light, or heat. This material is now available with improved sealing action and at costs competitive with leather and rubber due to Dixon's new post-forming technique!

Want complete data? See our Catalog in Sweet's Product Design File, or ask for Brochure #9572. **DIXON CORPORATION, Bristol, Rhode Island**

*DuPont Fluorocarbon Resin

Suppliers of basic shapes and fab-ricated parts in Rulan and Teflan





RESERVED

FOR THE ENGINEER
CONCERNED WITH
DESIGNING SAFE,
DURABLE,
FLEXIBLE LINES

Send for your copy of "FACTS YOU SHOULD KNOW ABOUT SWIVEL JOINTS"

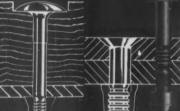
CHIKSAN

Written by engineers and well illustrated, this file contains a wealth of useful information on the application of swivel joints in line design. You'll find facts and figures on torque, geometric characteristics, thrust and radial loads. There's information on how to approach design problems and a quick comparison between swivel joints and other flexible devices. And, you'll find a group of actual installation reports with diagramatic drawings showing how the swivel joints were applied in the system. Be sure you have a copy of "Facts you should know about Swivel Joints" in your possession. Write Chiksan for your file today.

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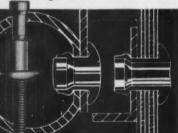
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Engineered for soft core panels, wood, plastics, as well as metal-to-metal use. Complete assortment of headstyles for any application. Full range of sizes and materials. Great strength, positive swaged lock.

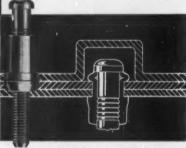


THE 9SP & PT

Low cost, blind fasteners for joining dissimilar materials, fast and easy to install. Solid core provides high shear strength or pulls through in PT to provide grommet hole.



A very broad bearing, wide grip range blind fastener for metal-tometal or soft material use. Fast, uniform, economical. Has positive swaged lock.



THE OS

A structural blind rivet with aluminum alloy sleeve and pin. High clinch and shear strength. Wide bearing and self-sealing. Use in metal, plastics or wood.

Huck's complete line of fasteners and simple, dependable installation tools offer speed, uniformity and economy for most fastening operations. Every Huck fastener is carefully engineered for its job. Our experienced fastener engineers will gladly help you in selecting the best fastener for your use.



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selection of knob, key, and coinactuated selector-switch operators, selector-pushbutton operators, and signal-light units. All are heavyduty, oiltight, dustproof devices built to JIC and NEMA standards. Mackworth Rees Inc., 1573 E. Forest Ave., Detroit 7, Mich.

Circle 785 on Page 19

High-Strength Adhesive

is two-component type

No. 10-001 adhesive offers peel strength of 63.3 lb-in. on aluminum-to-aluminum, and tensile shear strength of 3300 psi, a 3-4 day pot life, and 45 per cent elongation. Two-component adhesive is recommended for bonding aluminum honeycomb panels, ferrous metals, ceramics, and glass. Adhesives & Sealants Dept., Hysol Corp., Olean, N. Y.

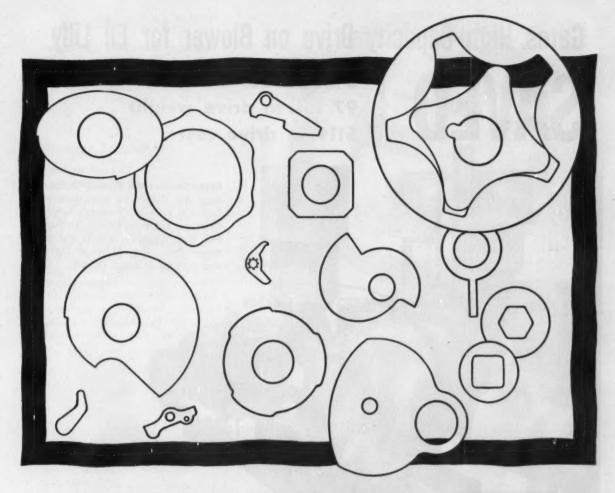
Circle 786 on Page 19

Inertia Switch

has only one moving part

Model 6UO-115 inertia switch is accurately preset to respond to acceleration forces from 1 to 25 g within a tolerance of ± 5 per cent of setting. It has only one moving part, a precision-ground steel ball held against a solid base by a uniform magnetic field. When opposing force of acceleration exceeds magnetic force, ball moves to close a normally open electrical contact.





NOT ALL GEAR SHAPERS CUT GEARS

... a lot of them are in production, cutting parts having non-involute shapes of various kinds. Many designers take full advantage of the versatility of the Gear Shaper by designing odd-shaped parts that can be easily and economically generated by merely using special Fellows cutters and fixtures on their standard Fellows machines.

The almost unlimited variety of work includes square and elliptical shapes, cams, pawls, pump rotors, etc., both internal and external.

Remember this *plus* value which helps guarantee a full, profitable work load on your Fellows generating equipment.

"The Art of Generating with a Reciprocating Tool", a fact-packed 48-page catalog, gives details on this versatile production technique. May we send you a free copy?



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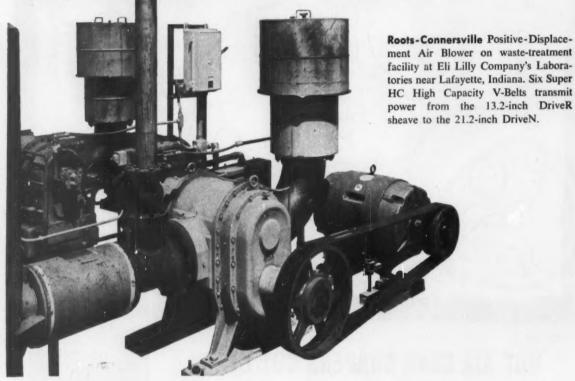
THE PRECISION LINE

Fellows

Gear Production Equipment

Gates High Capacity Drive on Blower for Eli Lilly

67/8" in face width 97 lbs. in drive weight \$119 in drive cost



For each blower that Roots-Connersville supplied for the Lilly Laboratories at Lafayette, Indiana, original drive specifications called for 11-groove sheaves using standard belts.

Because 11-groove sheaves were special and time was short, the original drive specifications were reexamined. Could Gates Super High Capacity V-Belt Drives handle the installation better?

They could - and did. Instead of 11-groove drives, regular 6-groove Super HC Sheaves and Super High Capacity Belts were shipped from stock . . . arrived at the job overnight . . . saved the situation - as well as time, money, space and weight.

For all users of multiple V-belt drives . . .

Gates Super High Capacity V-Belts offer similar opportunities to save. These Super HC Drives pack the same hp capacity into smaller space - require fewer belts, smaller sheaves, shorter center distances. The helpful design handbook "The Modern Way to Design Multiple V-Belt Drives" is yours for the asking. Just ask your Gates Field Engineer, listed in the Yellow Pages in the nearest industrial center.

The Gates Rubber Company, Denver, Colorado Gates Rubber of Canada Ltd., Brantford, Ontario



World's Largest Maker of V-Belts



same hp capacity in smaller "package"



Gates Super (HC) V-Belt Drives

Switch meets all environmental specifications of MIL-E-5272, including an operation range of -65 to + 200 F. Inertia Switch Inc., 311 W. 43rd St., New York 36, N. Y.

Circle 787 on Page 19

Miniature Terminal

secures directly to panel assemblies

Part 3FT3 is a feed-through terminal which secures directly to panel assemblies by means of an integrally molded threaded body. Flats which are also part of the integral mold make it easy to insert the threads into an assembly with either an automatic or manual coupling drive. Terminals are available in a full range of sizes and materials with male or female



threaded and rivet-type mountings in either molded or metal base. They are designed for a wide range of electrical applications such as tie points and insulators. Whitso Inc., MD-1 Byron St., Schiller Park, Ill.

Circle 788 on Page 19

Pressure-Gage Snubber

has maximum working pressure of 5000 psi

Pressure-gage snubber with 13 accurate settings prevents damage and excessive wear in sensitive gages. Maximum working pressure is 5000 psi. Variations in the snubbing action are accomplished by the selection of one of various combinations of three stainless-steel pins, each having a different diameter. Snubbing chamber is located on the side, permitting changing of pins without disrupting line connections. A blank hole is provided for storing the third pin while two are in use. Unit is available in highstrength forgings of brass and



COST-CUTTING PRODUCTION TEAM!

... the two-way answer to assembly problems



Assembly problems are a designer's problems, too. Here's a combination that cuts production costs and gets rid of assembly problems in a hurry—Milford Tubular Rivets made to high quality standards to assure a better finished product for you... Milford automatic rivet-setting machines that can be quickly adapted to your particular fastening needs.

Milford's Manual of Modern Rivering Practice may have the answers to your riveting problems. Ask a Milford Representative to show you how to use this manual to cut production costs.



MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT . NORWALK, CALIFORNIA ELYRIA, ONIO . AURORA, ILLINOIS . HATBORO, PA



Divisions of American Machine and Metals, Inc., New York 7, New York TROY LAUNDRY MACHINERY RIEHLE TESTING MACHINES • DEBOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC CO. • HUNTER SPRING CO. • GLASER-STEERS CORP.



stainless steel, in sizes of 1/4 and 1/2-in. internal pipe threads. Republic Mfg. Co., 15655 Brookpark Rd., Cleveland 35, Ohio,

Circle 789 on Page 19

Series-Wound Motors

have continuous-duty rating to 1/2 hp at 5000 rpm

Two 115-v, 60-cycle, series-wound motors are designed for such applications as industrial vacuum cleaners, small winches, flexible-shaft vibrators, and pipe threaders. Built in frame 3736, motors carry continuous-duty ratings to 1/2 hp at 5000 rpm and up to 1 hp at 10,000 rpm. Higher horsepower intermittent-duty ratings are also available. and reversible rotation can be obtained. Ball bearing construction is



used in the motors, which are designed for end mounting. Universal Motor Div., Robbins & Myers Inc., Springfield, Ohio.

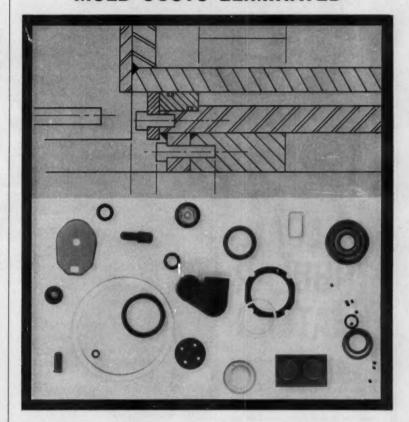
Circle 790 on Page 19

Cable Terminations

assure positive electrical connections

connectors available molded cable assemblies provide protection against moisture, minimize noise, eliminate shorts, and assure positive electrical connections. type junction ST-90 is exceptionally small and lightweight, and eliminates maintenance problems on headphones, binaural and stereo-

PARCO PROBLEM PROBERS **PRINCE** SPECIAL SILICONE MOLD COSTS ELIMINATED



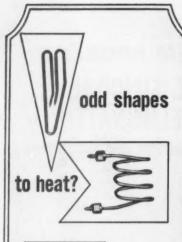
If the cost of furnishing special oversize molds has deterred you from using silicone custom molded rubber parts and "O" Rings in your product design, Parco has a ready answer for this problem. Parco scientists and engineers have now developed new compounding methods and production techniques which make it possible to produce both silicone molded rubber parts and "O" Rings in molds previously designed for standard parts. This eliminates the need for special oversize molds to allow for shrinkage during molding. These new silicone compounds, with mold shrinkage comparable to that of organic polymers, meet AMS and MIL Specifications in durometer hardness ranges from 50 to 80. Operational temperature range of the silicone products is, conservatively, from -70 to +480° F. O Enjoy the advantages of using silicone rubber products minus the extra cost of the specialized tooling formerly required. Consult with Parco engineers.

> Send for your latest Parco Slide Rule



Plastic and Rubber Products Company 2100 Hyde Park Boulevard Los Angeles 47, California **Plastic and Rubber Products Company** 2100 Hyde Park Blvd. . Los Angeles 47, Calif. Please send the Parco O-Ring Data Chart to: BUSINESS ADDRESS.

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use

VULCAN TUBULAR HEATERS

Vulcan Tubular Heaters can be formed into an endless variety of unusual shapes to provide a lot of heat in a little space. They are easily cast into aluminum or other metals. They are ideal for immer-sion in liquids, soft metals or molten salts. Straight tubular heaters are readily clamped to metal surfaces or inserted in machined grooves. And they can be furnished with flattened surface for even more effective heat transfer.

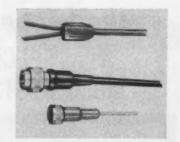
transfer.

Vulcan Tubular Heaters are available in a wide choice of lengths — 10" to 185" (special, shorter or longer); diameters — .250"; .280"; .333"; .450"; .496"; .540"; wattage — 10 to 10,000 (or higher); voltage — standard 120, 240 or 480; special 6 to 600 (or higher); sheaths — copper, steel, aluminum, high temperature alloys.

Write for catalog and prices.



NEW PARTS AND MATERIALS



phonic headsets. Molded housing provides exceptional durability. ST-26 is a four-contact, screw-type connector designed especially for microphone and electronic equipment, as well as all types of portable equipment. ST-25 is a single-contact microphone connector molded to a two-conductor shielded cable. It is suited for use on microphones, amplifiers, transmitters, tape recorders, and headphones. Switchcraft Inc., 5555 N. Elston Ave., Chicago 30, Ill.

Circle 791 on Page 19

Phenolic Laminate

has excellent flame retardance

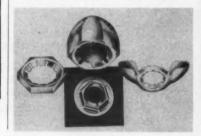
Insurok T-777 is a paper-base, phenolic laminate with exceptional flame-retardant characteristics. It is available in copper-clad or nonclad types. Material possesses good electrical properties, excellent dimensional stability, and superior punching qualities. It is classified as a hot-punching grade and requires moderate heating. Laminate is furnished in all standard sheet sizes, thicknesses, and tolerances. Richardson Co., 2735 Lake St., Melrose Park, Ill.

Circle 792 on Page 19

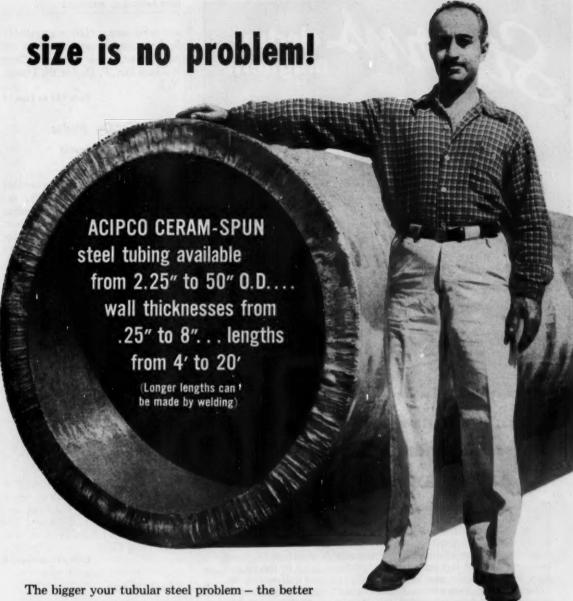
Stamped Fasteners

in heat-treated spring steel

Four new stamped fasteners include one-piece washer, acorn, regular,



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FINISHES: As cast, rough machined, or finish machined, including honing and grinding. Complete welding and machine shop facilities are available.

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and wing nuts. Nuts are available in heat-treated spring steel in all popular sizes and finishes. Crest Products Inc., P. O. Box 64, Union, N. J.

Circle 793 on Page 19

Silicon-Rectifier Diodes

are extremely versatile miniature units

Hermetically sealed silicon-rectifier diodes feature high stability, extreme versatility, miniature design, and rugged construction at low cost. Designated DI-52, DI-54, DI-56, DI-58, and DI-510, diodes have peak inverse voltage ratings of 200, 400, 600, 800, and 1000 v, respectively. All five types handle 750 ma at 25 C and 500 ma at 100 C. Ambient temperature range is -65



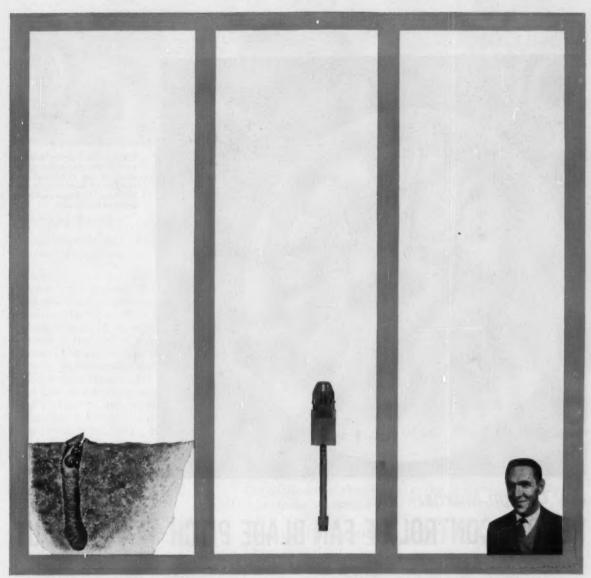
to +150 C. Extreme versatility makes each type adaptable to many applications normally requiring several different types of diodes. Diodes Inc., 7303 Canoga Ave., Canoga Park, Calif.

Circle 794 on Page 19

Check Valves

have one-piece, leakproof bodies

Featuring one-piece, leakproof bodies with a minimum of components, valves are constructed with soft seats to assure positive sealing. Simplified design permits large flow passages and in-line construction to minimize pressure drop and prevent loss of power. Design also features a horizontal poppet guide for accurate seating, efficient checking, and in-line, self-cleaning action. Built for operating pressure ranges to 5000 psi, valves are available in brass, steel, or stainless-steel bodies with 1/8 thru I-in. dry-seal threads or AND-10050 ports with straight

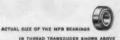


Underground Spinner. Not all spiders make webs. But all are skillful spinners of strong silk thread, for very different uses ranging from aerial "parachuting" to wrapping up prey. The trapdoor spider digs a deep hole, spins a gossamer coating for it, adds a hinged lid and lives securely in his silk-lined, expertly engineered burrow.

Tiny Thread Transducer. In textile weaving this new Mark III thread transducer — shown greatly reduced in size — helps eliminate moirè patterns by recording average and cyclic thread tension. Friction in the transducer's floating arbor is overcome by three MPB bearings cycled between 10,000 and 20,000 rpm 371 times per minute.

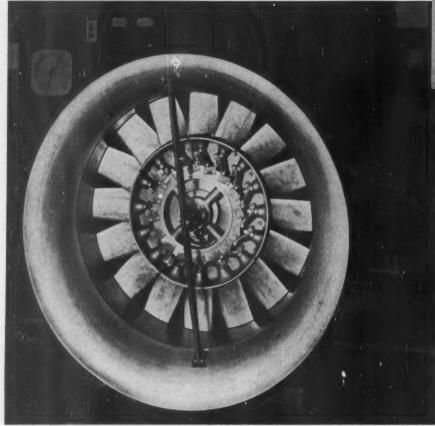
Man With Miracles. Like all MPB Sales Engineers, Harry Gabriel can tell you about the advantages MPB bearings are bringing to new, miniaturized devices like the Mark III thread transducer, throughout the country. For miniaturization of your own products he can also give you expert aid in reducing friction and inertia with MPB bearings.

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The more than 16,000,000 miniature and instrument bearings produced by MPB have met requirements in over 16,000 different types of applications. Developing bearings to aid in the design and manufacture of smaller, lighter, better components has always been a part of MPB service to customers. For details about MPB as a consulting and cooperating force — and for a catalog on MPB bearings, the world's largest line — write to Miniature Precision Bearings, Inc., 810 Precision Park, Keene, N. H.

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Pneumatic control valves permit simultaneous adjustment of the output of any number of fans. Simple mechanical linkage controls pitch of fan blades.

Joy Design Means:

REMOTE CONTROL OF FAN BLADE PITCH—FAN OUTPUT

Joy Controllable-Pitch Fans are designed to permit adjustment of fan blade pitch by remote control, in response to varying fan output requirements. A simple mechanical linkage maintains perfect calibration of all blades, and gives instant response to the control device. Blade pitch can be changed while the fan is running. The control can be manual, or the linkage in the fan can be tied to sensing devices which automatically change fan output in response to changes in humidity, temperature, CO2 concentration, etc. Should large volumes of air or gas be involved, any number of the fans can be controlled simultaneously by means of pneumatic valves.

Joy Controllable-Pitch is much more efficient than dampers or variable inlet vanes in varying fan output. Fan motors always run at their most efficient speeds, and there are no aerodynamic losses. In addition, the basic vane-axial design of the Joy fans provides greater aerodynamic efficiency than propeller and centrifugal types.

For accurate, efficient control of variable fan output, you can't beat the Joy Controllable-Pitch Fans. Response to controls is accurate and instantaneous, and fan efficiency is high at all levels of output. For complete details, write for Joy Axivane Fan Bulle-

tin 1214-64B.



MOVING EQUIPMENT FOR ALL INDUSTRY



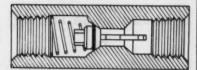






Joy Manufacturing Company Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario



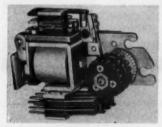
threads. Units can be installed easily and handle any fluids compatible with the material. Manatrol Corp., 2372 W. 7th St., Cleveland 13, Ohio.

Circle 795 on Page 19

Stepping Switch

has flexibility of contact operation

Cam-operated Type 200 stepping switch with unusual flexibility of contact operation makes an ideal memory device, as only a single impulse is required to switch and no power is required to hold it operated. Position of the switch remains unchanged by equipment or power shutdowns. Unit can also be used as a replacement for interlock relays or for use in applications where control of a sequence of operations is necessary. It is available in models with up to eight cams providing 30, 32, or 36 tooth ratchets. Operating speed is up to



60 steps per second interrupted, 30 steps remote-impulsed. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 11, Ill.

Circle 796 on Page 19

Pushbutton Switch

lighted unit is for dry circuit to 3 amp operation

Model 801, lighted pushbutton switch is available in single-pole, double or single-throw types. For dry circuit to 3 amp operation, it is designed for use in computers, data and message handling, missile ground-support equipment, machinetool control, and process control,



RMC external recalibration device saves time and your thermometer

With the patented RMC dial reset screw you can recalibrate your thermometer easily and safely, should it ever be necessary. The all-important hermetic seal cannot be destroyed, and there is no chance for damage to the critical pointer shaft.

What the RMC system of recalibration means to you

Sometimes it is necessary to recalibrate industrial thermometers due to severe shock from rough handling, or to calibrate for extreme accuracy at any point on the scale for special work range.

Various recalibration systems are employed in the different makes of ordinary bimetal thermometers. Most all of them will achieve the desired recalibration, but a number of undesirable things may also result. In some, all semblance of air-tight seal is automatically destroyed in removal of the dial glass. In others, the criti-

cal pointer shaft may become bent or twisted. And still others use a mechanism incapable of holding the new setting for any length of time. None of these things can possibly happen with RMC's patented recalibration device.

A simple dial-reset screw, located on the back side of RMC thermometers, permits recalibration without opening the instrument in any way—

thus leaving its air-tight hermetic seal intact. Its positive meshed-gear mechanism rotates the dial itself in a way that cannot under any circumstances cause damage to the pointer shaft. And the new setting will hold indefinitely.



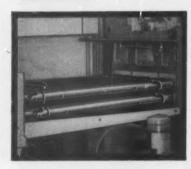


Write, wire or phone for general catalog. If yours is a special application, tell us your requirements—RMC engineers will work with you in solving it. Rochester Manufacturing Co., 229 Rockwood St., Rochester 10, N. Y. (Telephone: BRowning 1-2020).

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The close center-to-center spacing of these drive spindles on a Sutton-Maust Precision Backed-up Roller Leveler created a tough problem for its manufacturer. He needed a universal joint strong enough to stand up under heavy rolling mill conditions, yet small enough to operate at such close quarters.

The answer was a Curtis universal joint! The maximum load carrying capacity and minimum torsional deflection of the Curtis joint was found to be completely satisfactory. And Curtis' famous Telltale Lock Ring construction permits quick disassembly for easier maintenance.

This is just one of the many power transmission problems solved by Curtis universal joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and 40 years' experience manufacturing universal joints exclusively make them that way.

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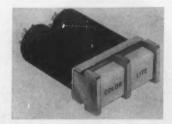
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Circle 552 on Page 19

NEW PARTS AND MATERIALS



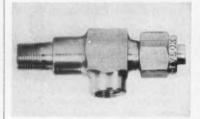
wherever an indicating switch is required. It utilizes standard, midgetflange, single-contact bulbs. Unit mounts on 1-in. centers. Pushbuttons are available in a wide range of colors with legends covering $\frac{3}{4} \times \frac{7}{8}$ in. Color-Lite Div., Sloan Co., 7704 San Fernando Rd., Sun Valley, Calif.

Circle 797 on Page 19

T-Fitting

provides high degree of sealing safety

Tylok four-seal T-fitting embodies four positive seals against pressure, temperature, vibration, surge, plus vibration dampener. It eliminates the need for adapters, connectors, and special fittings when applying pressure gages or other instruments to hydraulic, pneumatic and process lines. Fitting gives the benefits of a single-piece installation. Econ-



omy, ease and speed of installation, and a greater measure of sealing safety are assured. Unit is available in aluminum, brass, Monel, steel, and 316 stainless steel. Fitting is available in sizes from 1/16 through 2-in, diam with pipe thread. C. B. Crawford Co., 16606 Waterloo Rd., Cleveland 10, Ohio.

Circle 798 on Page 19

Speed Reducer

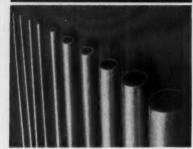
for horsepowers from 1/4 to 12 hp

Shaft-mounted speed reducer produces single, two, and three-speed

quick source for fine Seamless Tubing

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Excellent cathode emission, high strength and rigidity at elevated temperatures for electronic and instrument applications.

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30 CUPRO-NICKEL

Copper-based alloy widely used for fine wire connectors, prongs and electrical contact tips, electrical and medical instruments.

Sizes: from .010" O.D. to .375" O.D. Wall Thicknesses: from .042" to .001".

Tolerances: $\pm .0005''$ to $\pm .00025''$. Delivery: Normally 5 to 6 weeks.

Fabricated Parts: a complete service.

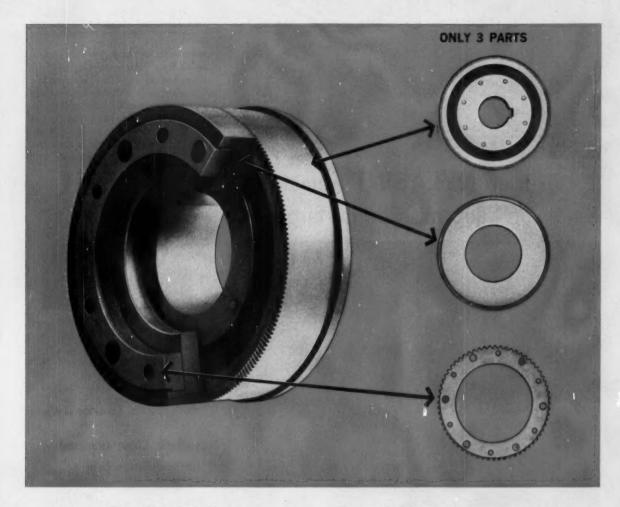
Write for information on tubing or tubular parts, made from these alloys, as well as many other alloys of aluminum, copper, steel, the precious metals and glass-sealing alloys.

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INC. 1200 Level Rd., Collegeville 2, Pa. HUxley 9-7276



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Simplified design means more dependable performance

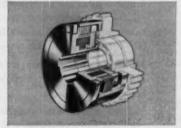
BENDIX ELMAG (Electromagnetic) TOOTH CLUTCH

With only three parts, the Bendix® Elmag tooth clutch provides a simple, positive, compact clutch package for machine designers. The Elmag offers greater torque transmittal than other clutches of the same size. This means you can design for either greater machine capacity or space savings—or both.

For the end user, the Elmag offers the following dependable performance features. There is absolutely no idle torque—no connection between driving and driven members once disengaged. The Elmag can be disengaged under full load at any RPM, and engagement at relative speed is possible. The clutch's simple, bolton design makes it easy to mount; there are no additional splines or springs, no external disengagement

mechanism. Elmag tooth clutches are designed to perform in either wet or dry applications. They are available from stock in torque capacities ranging from 40 to 4,000 ft.-lbs.

BENDIX ELMAG MULTIPLE DISC CLUTCH—Ideal for step-by-step acceleration of large masses. Disc stack is magnetically isolated. Wet or dry operation. Slip ring or stationary field design. Torque capacities: 10 to 16,000 ft.-lbs.



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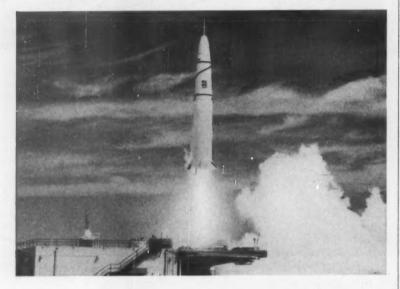
Bendix-Elmira

Eclipse Machine Division Elmira, New York





Oil-filled NYLASINT® retainer helps keep missiles on target



Ball bearing retainers of oil-filled, micro-porous Nylasint have unique resistance to bleeding under extremes of temperature, pressure and acceleration. Leading builders of inertial guidance systems are taking advantage of Nylasint's unique oil-holding characteristics for improved lubrication and performance of gyro rotor bearings. Nylasint retainers prevent navigational errors induced by even the slightest shifting of oil masses.

Sintered from finely divided nylon powder and impregnated with oil, Nylasint parts retain up to 50% (by weight) of the lubricant to minimize friction in bearing and wear applications. Almost 20% of the initial oil is retained at accelerations of 15,000 G's.

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industrial plastics

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a subsidiary of
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Reading, Pa.

reductions for horsepowers from $\frac{1}{4}$ to 12 hp. New unit, only 10.6 in. diam and $4\frac{3}{4}$ in. wide, is unusually compact. All reductions are within the dimensions of the pulley, inside the housing, providing for reductions from 2.52:1 to 76:1. Model D can be supplied as a plain speed reducer, or as a speed reducer with



friction clutch, giving reduced speed plus pulley speed, or is built as a two-speed reducer with both speeds clutch controlled. Speeds can be in the same or opposite directions. Hart Reduction Pulley Co., 1116 Adams St., Waukesha, Wis.

Circle 799 on Page 19

Synthetic Chain Lubricant

for temperatures from -65 to +300 F

Anderol L-732 is a semifluid lithium grease with a medium viscosity diester oil base. Tackiness, penetration, and good extreme-pressure qualities assure troublefree, long-term chain lubrication from a single application. Temperature range is -65 to +300 F. Material offers resistance from rust and water, prevents wear and lengthening of the chain, and will not form gums, sludges, or harmful deposits. Industrial Lubricants Div., Lehigh Chemical Co., Chestertown, Md.

Circle 800 on Page 19

Sealing Grommet

has spring-steel retaining tabs

Arco sealing grommet is a snap-in, cellular-sponge plastisol which can be molded to suit any required situation, in any size, shape, or dimension. Design, with spring-steel retaining tabs, insures positive seal between grommet membrane and sheet metal. It is nonabsorbing and

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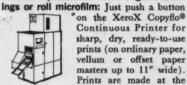
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on the XeroX Copyflo® Continuous Printer for sharp, dry, ready-to-use prints (on ordinary paper, vellum or offset paper masters up to 11" wide). Prints are made at the

rate of 20' a minute. Copyflo printers enlarge, reduce or copy size-to-size from original drawings or roll microfilm (16 or 35mm).

Reproduction from card-mounted microfilm: The XeroX Copyflo 24 C and the exciting new Copyflo 1824 automatically produce dry, positive prints on ordinary paper, vellum or offset paper masters from 35mm card-mounted microfilm! The Copy-



flo 24C produces ready-to-use prints (up to 24" x 36") at the rate of 20 linear feet a minute! The new low cost Copyflo 1824 for small vol-

ume users or large, decentralized users, produces prints from 81/2" x 11" to 18" x 24".

GET ALL THE FACTS! Send for EDX Booklet today. Write: HALOID XEROX INC., 60-116X Haloid St., Rochester 3, N.Y. Branch offices in principal U.S. and Canadian cities. Overseas: Rank-Xerox Ltd.,



HALOI XEROX

Circle 556 on Page 19





Completely oil-tight and dust-tight. Mounting panel is removable. Standard single door sizes now include many 8" and 10" deep enclosures to accommodate large circuit breakers and disconnect switches. Besides two-door models, we now offer three, four, and five door models up to 15½ feet long. Also available in NEMA Type 4,



A control housing for locations that do not require the oil and dust-tight characteristics of HOFFMAN NEMA Type 12 enclosures. Removable mounting panel. Doors have lift-off hinges and plated "flush" latches.



This new JIC Sectional Wireway (Patent Pending) offers the "lay-in" feature which simplifies installing wires from control point to equipment. Cover has full length hinge and is gasketed to seal out liquids. Many sizes in stock.



Hoffman corporation
Dept. MD-141, Anoka, Minnesoto

NEW PARTS AND MATERIALS



prevents chafing, cutting, shorting, and rattling. Readily removed and replaced to position without injury, it provides protection for ragged edges of blanked holes and offers high degree of efficiency in eliminating sound and vibration. Unit positively seals out water, moisture, mud, dust, gases, and fumes. It is available in various elastomeric insulating materials to meet specific demands. Automotive Rubber Co., 12550 Beech Rd., Detroit 39, Mich.

Mercury Switch

is shock proof and waterproof

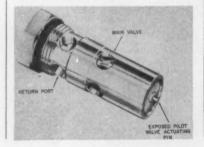
Low-cost, 2-amp mercury switch, HG 426 MI, has a nominal diameter of 0.500 in. and a nominal length of 1-11/16 in. It is shockproof, waterproof, and operates on any axis. Switch and leads are potted in rigid PVC for complete moisture protection. Gordos Corp., 250 Glenwood Ave., Bloomfield, N. J.

Circle 802 on Page 19

Cartridge Relief Valve

regulates hydraulic circuit flow

Cartridge relief valve, designed to give instant response to surge pressures in any hydraulic circuit, plugs into any housing which has pump pressure and provision for return to the reservoir. Pin and hole orifice at inlet pressure port is self-cleaning,



SICON the original silicone base

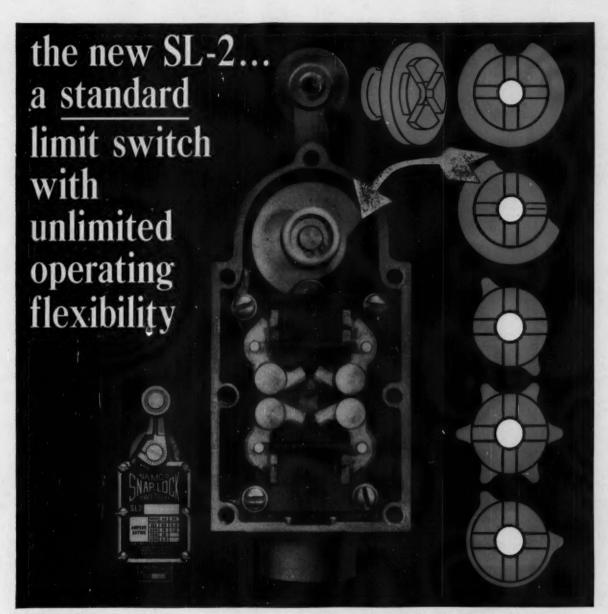


of High Temperature
Combustion Tube Furnaces



The Hevi-Duty Combustion Tube Furnace offers excellent high temperature uniformity—for extended periods of time with minimal heat loss. Sicon, in an attractive metallic green, protects both *inside* and *outside* of steel shell. It does not peel, flake or lose original color—even at temperatures approaching the 1000°F. range. Sicon is the *proved* protective coating for all hot surfaces . . . from manifolds to missiles. Write for latest brochure *now*. Address Dept. J-9.





Tailor limit switch performance to your specific job with NAMCO'S standard SL-2. This "machine life" limit switch features a standard cam blank which can be cut into a wide variety of configurations to meet any application. These interchangeable cams provide positive control of contact sequence; let you match switch operation to your specific job. Ruggedly built, oil-tight and moisture-proof, the SL-2 provides dependable, accurate performance that meets your most precise requirements.

Now available for low-current, high-shock, excessive-vibration applications...the SLS-2...

with full-wiping, self-cleaning sliding contacts that insure "everytime" operation under conditions that spell machine downtime for other limit switches.

Get all the details on how the NAMCO SL-2 line eliminates limit switching problems for good. Write for Bulletin EC-SL260, or contact one of our representatives. You'll find them in all principal cities.

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Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.



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Syracuse * Boston * Chicago * Detroit * Toronto Pittsburgh * Cleveland * Seattle * Houston Philadelphia * Los Angeles * San Francisco with the pin moving in the hole with changing pressures, eliminating clogging and excess dirt. Actuating pin is exposed to line pressure at all times, providing instant response to pressure surges. Constant regulation of pressure between cracking and full open is provided. Cartridge relief valve has a capacity of 30 gpm. Hydraulic-Electronic Div., Fawick Corp., 9919 Clinton Ave., Cleveland 11, Ohio.

Circle 803 on Page 19

Brake Unit

is for 40-frame motors

Spring-set, solenoid-released brake unit for 40-frame motors has a torque rating of 3 lb-ft. Style H 44 unit is available in ac and dc, with dripproof enclosure. Rated at 1 lb-ft, unit is suited for use on small



hoists and weighing devices where large torque and small size are required. Stearns Electric Corp., 120 N. Broadway, Milwaukee 2, Wis.

Circle 804 on Page 19

Hydraulic Cylinders

in 11/8 to 12-in. bores

Series C4H interchangeable 2000-3000 psi hydraulic cylinders are furnished with 11/8 to 12-in. bores with 17 mountings. Rugged units meet or exceed JIC standards, feature tie-rod construction for maximum strength and shock loading, have long-wearing, easily maintained rod cartridges, and four different types of piston packing for various applications. Heads, retainers and mountings are machined steel; cylinder tubes are microfinished seamless steel, sealed with O-rings located to eliminate extrusion. Piston rods are 110,000 psi, high-tensile steel, hard-chrome



In this KENNAMETAL* lined container, some of the hardest materials known to man are reduced to powder

Tungsten metals, silicon carbides, asbestos fibers, blast furnace slag, copper shot, alumina beads . . . are all conquered in this grinding vial used in a laboratory size mill.

Such materials pack, thereby preventing thorough grinding. At the same time, they peen out, smear and erode the surfaces of the usual mortar and pestle or ordinary ball mill. But the Spex Mixer Mill, using Kennametal Balls in a Kennametallined cylinder, can grind a lab size sample down to -300 mesh or finer in just 10 minutes. Grinding is uniform, with hardly a trace of contamination.

The hardness of Kennametal (up to 94.7 Rockwell A) makes the difference. Hardness is but one of the many exceptional properties of Kennametal. When you need a material with great rigidity, resistance to heat, corrosion, abrasion, erosion, and compression . . . chances are Kennametal may be the answer.

To help solve an immediate problem, or a future need... we'd like to send you Booklet B-111B "Properties of Kennametal" and our new Booklet B-666, "Proven Uses of Kennametal and Kentanium." * Write Dept. MD, KENNAMETAL INC., Latrobe, Pennsylvania.

*Kennametal is the registered trademark of a series of hard carbide alloys of tungsten, tungsten-titanium, and tantalum. Kentanium is the registered trademark for one of the series that has special advantages for applications requiring a lighter weight material or maximum resistance to temperature extremes.



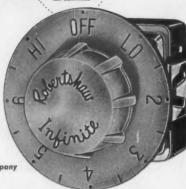


ACTUATES ANOTHER PRECISION PRODUCT...

Robertshaw *.

Electric Infinite Control

A product of Robertshaw-Fulton Controls Company Indiana, Pennsylvania



Range manufacturers wax enthusiastic over this new development from Robertshaw. And well they might, because this is one Infinite Control designed with the manufacturer in mindl For instance: the new model INF (pictured) is approximately the same size as an ordinary five-heat rotary switch, making it fully interchangeable at any time in the production cycle. The range builder needs to stock only one type control for all elements.

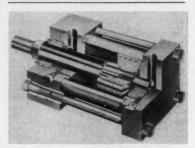
The Robertshaw Electric Infinite Control model INF turns clockwise or counterclockwise and is equipped with three indexing positions: "Off," "High," and "Low." In the "High" position, the control is energized continuously. At other settings it delivers the selected input level under the control of a bimetal timer. A second bimetal is employed as an ambient temperature compensator to neutralize the effect of ambient temperature changes on, the control bimetal. Both of these important components are made of Chace Thermostatic Bimetal.

By specifying the inclusion of Chace Thermostatic Bimetals in "the most advanced concepts in electric controls," Robertshaw joins many manufacturers who know they can depend on Chace. This dependability is born of more than 30 years of manufacturing only one product: precision bimetal. Any manufacturer can be sure his name is safe on the outside with Chace Thermostatic Bimetal on the inside of his product.

OUR NEW INFORMATION BOOKLET IS READY NOW!

If your new product is approaching the design stage, send for "Information Booklet". It contains design data, illustrations and applications for more than 30 types of Chece Thermostatic Bimetal. Chace bimetal is available in stripes, coils and in completely fabricated elements of your design.





plated to insure smooth surface and excellent corrosion resistance. Sheffer Corp., 326 W. Wyoming Ave., Cincinnati 15, Ohio.

Circle 805 on Page 19

Silicone Rubber

is low-viscosity material for molding and casting

Silastic RTV 521 low-viscosity silicone rubber offers processing advantages in making molds, prototypes of models, and in casting applications. It flows readily through narrow channels and deep draws and fills fine cracks, crevices, and depressions of intricate designs for accurate surface reproduction and void-free sections. Viscosity will not change significantly during storage. Fully cured Silastic RTV 521 is serviceable over a temperature span of -70 to +500 F, and withstands temperatures to 600 F for short periods of time. Dow Corning Corp., Midland, Mich.

Circle 806 on Page 19

Chassis Latch

provides positive latch and locking section

Miniature Gripwell latch is designed for small 5½-in. standard electronic chassis drawer. Double safety latch provides positive latch action and positive locking action, preventing accidental openings of the drawer under any condition. Latch pro-



HOW TO DESIGN A TRADEMARK

Why, it's easy as A-B-C. Just start with a simple shape, one that's readily identified and easily remembered. (The Jenkins Diamond is a good example.) Then just fill in the blank spaces. That's all there is to it, and almost anyone can do it!

HOW TO MAKE IT MEANINGFUL

Ah, that isn't so easy nor so simple.

A trademark is like a man's signature: it can mean much or it can mean little.

Time and performance make the difference.

Take the Jenkins Bros. trademark. There's nothing tricky about the design, certainly nothing fancy about the words.

Yet buyers and specifiers of valves everywhere know and respect this simple device, this mark.

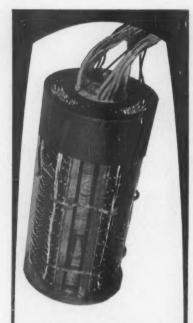
Why? Because in all the years since 1864 there has been no compromise in the *quality* of Jenkins Valves. We know it; you know it.

And that is the only way we know to make a trademark meaningful. That will always be the Jenkins way of making valves.





JENKINS BROS., 100 PARK AVENUE, NEW YORK 17



NEW SERIES of Antenna SLIP RING Assemblies

12 to 500 RINGS

A standardized line of large Slip Ring assemblies, designed for a multiplicity of instrumentation, control and power circuit applications. First production assemblies are in use on radio telescopes, radar and tracking antennas and human centrifuge installations.

Assemblies vary from 12" to 72" in length, are either shaft or flange ball-bearing mounted and may be specified with hermetically sealed housings. Noise levels are held to a minimum. So are intercircuit losses, cross-talk and radiation, through proper shielding.

For complete information, write:



SLIP RING COMPANY of AMERICA

3612 West Jefferson Blvd., Los Angeles 16, Calif.



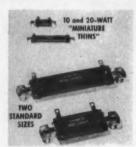
vides a 6.5:1 mechanical advantage for positive injection and rejection of the drawer and also allows for $\frac{1}{2}$ in. of travel or take. Latch housing can be used to carry the drawer, irrespective of the position of the latching handle. Over-all size of the latch is 4.7 in. and it extends 1.4 in. from force of chassis drawer. Hartwell Corp., 9035 Venice Blvd., Los Angeles 34, Calif.

Circle 807 on Page 19

Miniature Resistors

are furnished in 10, 15, 20-w sizes

Miniature Thin resistors for applications where space is at a premium are unusually small for their power-handling capability. The wirewound, vitreous enameled units



are available in 10, 15, 20-w sizes. Cores are only ½ in. thick, and the 10-w unit is only ¾ in. long. Heat dissipation is aided significantly by the mounting brackets on the miniature units. Body of the bracket extends through the core, distributing heat more evenly to minimize hot spots and conducting heat directly to the chassis or mounting surface. Ohmite Mfg. Co., 3609 Howard St., Skokie, Ill.

Circle 808 on Page 19

DC Motors and Generators

incorporate new ventilation system

Totally enclosed dc motors and generators are designed for both constant-speed drives and drives involving fast, wide speed changes and reversals, automatic control, or close regulation. Line includes totally enclosed fan-cooled and totally enclosed nonventilated machines in both industrial and explosionproof construction. Motors



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If you are joining metal, plastic, porcelain or asbestos, you should know about Townsend Tuff Tites. Ask your Townsend representative, or we will send you complete literature. Townsend Company, Engineered Fasteners Division, P.O. Box 71-E, Ellwood City, Pa.



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In Canada: Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario



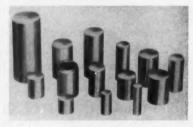
are rated from 1/2 to 60 hp at 300 to 3500 rpm, and generators from 3/4 to 40 kw at 850 to 3450 rpm. High-temperature silicone insulation system is used for machines rated and built for continuous operation with a temperature rise of only 75 C. New high-capacity system of controlled ventilation has blowers and heat exchanger mounted at the shaft end. Advantages include fast response, stability, and increased insulation life. Armature inertia has been decreased 75 per cent over previous models. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Circle 809 on Page 19

Round Cases

house electrical components

More than 200 standard sizes of drawn round cases are made from aluminum, copper, steel, brass, and mu metal. They are especially designed for many applications, including the housing of electronic com-



ponents, canning, and packaging. Cases range in size from 1/2 to 3 in. diam and lengths to 4 in. Olympic Products Co. Inc. Alpha, N. J.

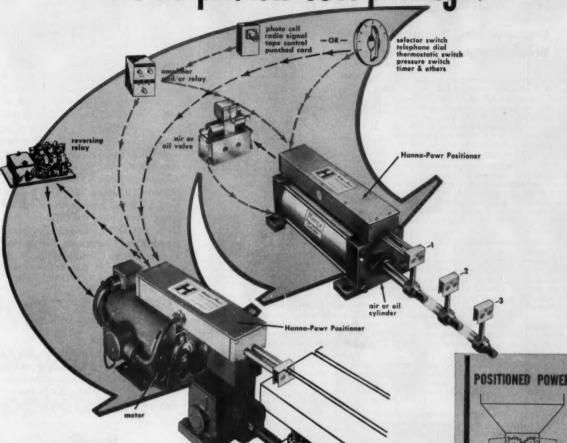
Circle 810 on Page 19

Printed-Circuit Plug

for edge mounting on 1/16 and 1/32-in. boards

Cambion 0.045-in. diam plug No. 2850 is designed primarily for use in printed circuits and particularly for

BRAND NEW IDEA...multiple positioning in a simple, low cost package!



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THE NEW HANNA-POWR POSITIONER is a simplified, low-cost servo-mechanism used with air or hydraulic cylinders, electro-mechanical or other power drives to responsively achieve predetermined positions. The POSITIONER will also feed a signal to a read-out station to indicate the position point. Controls, such as selector switches, timers, thermostatic switches and others, feed signals to the POSITIONER for station selection—as many as 14 per foot of stroke. Infinite variations in positions are possible by simple movement of the adjustable limit switches.

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Your individual problems will suggest many uses for the HANNA-POWR POSITIONER. For more detailed information call your nearby Hanna Representative, (See "Cylinders" in the yellow pages), or write us for Catalog 500.

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PRECISION BALL BEARINGS

NEW HDR SERIES

More Bearing in Less Space

Fractured Ring Technique Provides Breakthrough to High Performance

Understandably, selecting a precision ball bearing in which the outer ring has been intentionally fractured is difficult for many engineers long used to thinking in conventional terms of bearing quality. Just as the nameless pioneer who ate the first oyster discovered, despite his pable qualms, that it was extremely palatable and healthful, we hope you'll read on and discover the many advantages of HDR ball bearings.

HDR ball bearings combine the capacity of maximum ball complement bearings with the overall performance characteristics of Conradtype ball bearings, plus the advantage of a one-piece outer land-riding retainer. This new high performance bearing is made possible by Split Ballbearing's patented fractured ring construction method.

The development of the HDR bearing by Split Ballbearing engineers grew out of the d for a high performance deep-groove ball bearing, dimensionally interchangeable with standard metric sizes, but with considerably greater capacity and life. General proportions between ball size, ring thickness and raceway shoulders were already well established. The problem was to introduce a greater number of the same size balls between the inner and outer rings without resorting to performance-limiting construction features such as loading slots or counterbored

The construction and assembly of the HDR bearing is the unique solution to the problem. Many hundreds of successful applications of HDR type bearings testify to the sound practicality of their design.

The deep, uninterrupted and symmetrical raceways in both rings of HDR bearings permit relatively high thrust loads in either direction and are ideal for high speed operation. Conrad-type bearings have similar raceway construction, but considerably less load capacity due to their smaller complement of balls.





Conrad type construction - note how ball com-plement is limited to about half of available space due to eccentric displacement of rings.

HDR bearings have up to 56% greater load capacity than equivalent size Conrad types. Since bearing life varies inversely as the cube of the applied load, HDR bearings will yield or the applied load, HDR bearings will yield up to 280% greater life, at a given load, than Conrad-type bearings of the same size. How do Split engineers build these high performance bearings? It's relatively simple—look at these diagrams:







ed, to permit assembly or a ximum ball complement iring without loading slots or interbored rings. bearing with



sufficiently so it may be snapped over assembly of balls,



into O.D. shoulder grooves to prevent opening during han-dling and installation.

Using maximum ball complements, HDR bearings offer greater rigidity, with an average of 26% less deflection than Conrad-type bearings. Because of their higher radial static capacthey have an average resistance to shock loads 43% greater than Conrad-type bearings.

A further important advantage of the HDR construction and assembly method is the use of a simple one-piece ball retainer of maximum strength. The retainer is made of bronze, for low friction, and is piloted on the ground shoulders of the outer ring. This piloted, or land-riding construction, keeps the retainer concentric with the bearing rings under all conditions of operation. Because there is more room for retainer material outside the ball circle diameter than inside, the outer land-riding design provides maximum strength. Since the balls do not have to support the weight of the retainer, friction is minimized at the points of high velocity sliding in the ball pockets, thus permitting higher oper-

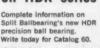
HDR ball bearings are made in four standard AFBMA series of bearing envelope proportions: Series 000 extremely light Series 200 light Series 100 extra light Series 300 medium

The present size range is from 10 mm bore through 85 mm O.D. They are available in two grades of precision — ABEC-3 and ABEC-5.

The handling and mounting of HDR bearings is exactly the same as for conventional precision ball bearings.

NEW CATALOG on HDR series





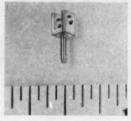




ballbearing A DIVISION OF MPB, INC

311 HIGHWAY FOUR, LEBANON, NEW HAMPSHIRE

NEW PARTS AND MATERIALS



edge mounting on 1/16 and 1/32-in. printed-circuit boards. However, it can also be used for conventional circuits. End of shank is slotted to a depth of 0.125 in. and is available in two slot widths to accommodate the two board thicknesses. Plug has a pin 0.045 in. in diam and is approximately 13/64 in. long. Plug mates with jacks No. 2378 and 2650. Material is brass per QQ-B-626a, Comp. 22, 1/2 hard with 0.0002-in. silver plate plus 0.000020-in, gold flash or 0.0002-in. bright alloy plate. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass. Circle 811 on Page 19

Solenoid Valves

for operation from 0-1500 psi

Series 15,000 solenoid valves are direct-lift, full-ported economy valves designed for reliable operation from 0-1500 psi. Bubbletight, leakproof, and packless, they are available in



bronze or stainless steel in 1/4 to 1in. pipe sizes for temperatures from -350 to +450 F. Atkomatic Valve Co., 545 W. Abbott St., Indianapolis,

Circle 812 on Page 19

Door-Retaining Spring

provides easy access to small doors

No. 50 door-retaining spring consists of a tiny steel spring and cam device that holds a door firmly in



your guide to the gear pump for your application

This new catalog is an invaluable directory to no less than 129 pump-and-electric-motor-combinations — any and all available off-the-shelf!

Searching for gear pumps with top volumetric efficiencies? Do your performance requirements fall into one of these three major groups?

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- Eastern 100 series up to 5 gpm pressures up to 1500 psi

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If one or more of these performance ranges measures up to what you need, save hours of searching your way through the gear pump maze — send for catalog 810 now!



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Hamden, Connecticut

NEW DUAL-BEARING UNIVERSAL

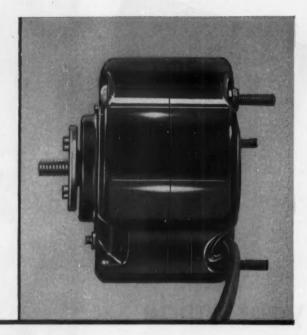
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provides dependability

and long life in

Refrigeration Fan

Applications

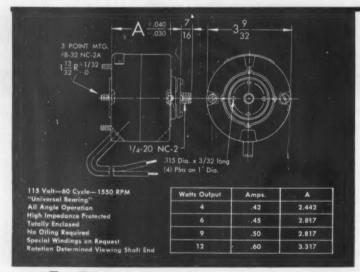


The Type 118H-3, shaded-pole hubless fan-motor is a rugged, new, precision built motor that has been specially designed to precisely meet the needs of refrigeration manufacturers. The 115 volt-60 cycle-1550 RPM model is totally enclosed and suitable for all angle operation. It conforms to all existing dimensions and has the standard 3-stud mounting and the 4-pin hubless adapter so that it can be installed as original equipment without modification.

This new Type 118H-3 has two free-aligning Universal Bearings located at either end of the shaft rather than a conventional single bearing. These bearings are of an advanced design and eliminate fractional HP motor problems due to misalignment. Each

has its axis of support at the center, rather than at the end; they are therefore always in balance and adjust themselves to shaft misalignment under any load conditions. This results in longer bearing life and assures a motor that is efficient, sure starting and quieter. These bearings are self-lubricating and each one incorporates an extra large, life-time oil reservoir.

Due to the two free-aligning Universal Bearings, the newly designed laminations and the improved rotor construction, the Type 118H-3 Universal Motor will provide years of reliable, trouble-free operation. Special windings are available on request; write for complete information.





New Universal Bearing has support pressure on center of bearing rather than the end to eliminate uneven tension and permit adjustment of axis position to true alignment. Neoprene collar around outside surface of bearing accommodates manufacturing tolerances; small metal clips confine collar, allow free sliding movement along bearing support surface.



UNIVERSAL ELECTRIC COMPANY

PRECISION ELECTRIC MOTORS

EXECUTIVE AND GENERAL SALES OFFICES: OWOSSO, MICHIGAN, DEPT. 10

54



both open and closed positions. Made especially for miniature doors, it has a maximum moment of $\frac{3}{4}$ lb-in. Installed on the inside of equipment, spring is completely invisible from the outside. Very little inside space is required for clearance. Installation requires no special tools. Location of spring and cam is interchangeable. Assembly weighs only 0.014 lb. South-co Div., South Chester Corp., Industrial Highway, Lester, Pa.

Circle 813 on Page 19

Revolving Connection

forms a positive seal

Rotary Union is a revolving connection that forms a positive seal between a stationary supply line and revolving equipment. Type P is a single-inlet unit which conveys liquids or gases into or out of revolving machines, rolls, or drums. Type S has dual pipe connections where both supply and return of gases or liquids are required within the same unit. Mechanical seal automatically adjusts to the actual pressure of the media being transferred. Ball-bearing construction and self-aligning reduces strain and wear on the seal, assuring long, troublefree service. Unit handles steam, water, air, vacuum, gases, and industrial fluids on applications





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you combat them all with an AMPCO metal

What does a copper-base alloy have to do for you? Whatever it is, there's a grade of Ampco metal — or other Ampco alloy — that does the job exactly.

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Call in your Ampco field engineer. Write for bulletin.

0-200

AMPCO METAL, INC., Dept. 30J. Milwaukee 46, Wie. WEST COAST SIV.: HUNTINGTON PARK, CALIFORNIA - SOUTHWEST BIV.: CARLAND (DALLAS COUNTY), TEXAS



When a test pilot rockets into the outer atmosphere for the first time driving ex-perimental craft such as North American's X-15, he'll feel as though he's been there before.

Before his first actual flight, the pilot trains for many hours in "dry land" rocket craft. There, he learns to cope with upper atmosphere problems as posed by an analog computer. Every time he touches a control, the computer responds and the result appears on the instrument panel in the training cockpit. The entire bank of instruments reacts as though he were really "up there." In this way, the pilot meets every conceivable situation long before he takes his powerful bird aloft.

And what does Spectrol have to do with this important training program?

Spectrol makes the link that joins the computer and the bank of instruments in the cockpit. This link, known as a servo repeater, translates the computer's information into meaningful dial readings. As you know, such information must be transferred quickly and accurately.

Spectrol servo repeaters do just that. Key specifications for a typical unit now in production are:

Maximum velocity: 360°/sec Acceleration in excess of 7000°/sec² Static accuracy better than 0.25 deg. at output shaft Other applications for Spectrol packaged servo repeaters include dial drives on GCA equipment, airborne computers and dc systems in general.

Spectrol PRECISION MECHANISMS free the systems engineer from building functional sub-assemblies. If you need precise logical system modules combining in a single specification sub-assemblies using components such as gear drives, clutches, precision potentiometers and servomotors

—Spectrol can help.

For complete information, call your nearest Spectrol engineering sales representative, or address Dept. 63.



ELECTRONICS CORPORATION 1704 SOUTH DEL MAR AVENUE . SAN GABRIEL, CALIF.

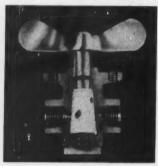
Circle 572 on Page 19

NEW PARTS AND MATERIALS

to 250 psi and 150 psi steam, temperatures to 500 F without adjustments. They are available in pipe sizes ½ through 3 in. with right or left-hand threads. Machine threads are furnished for speeds over 600 rpm. Perfecting Service Co., 332 Atando Ave., Charlotte 6, N. C. Circle 814 on Page 19

Plug Valve

incorporates a Teflon plug



New plug valve with a Teflon plug solves problems of friction, heat, corrosion, and leakage. Teflon plug seats against the heavy-duty forged body, and a thin film of Teflon is transferred from the plug to the mating surface of the valve body. Natural self-lubricating properties and low coefficient of friction eliminate need for oil or grease. Valve is for operation with air, oil, water, and gas. It is rated for service to 250 lb at temperatures from -320 to +500 F. Valve is completely resistant to nearly all chemicals, gases, and solvents. Unit is available in IPS sizes 1/8, 1/4, 3/8, and 1/2 with two, three, four, or fiveway drillings. Conant Bros. Co. Inc., 427 Riverside Ave., Medford, Mass.

Circle 815 on Page 19

Encapsulated Motors

provide open-motor performance

Howellsealed encapsulated motors are three or two-phase, I through 125 hp, ac squirrel-cage units. Seal is a specially developed epoxy compound, applied under vacuum to surround each wire in slots and at coil ends to produce a solid, voidfree mass. Motors have simplicity and high overload service features of



SPECIFY THOMAS FLEXIBLE COUPLINGS

Like a THIEF in the NIGHT an inferior coupling causes wear and damage to your machines - resulting in high maintenance costs and costly shut-downs.

Troublesome maintenance problems and down time are eliminated when you specify Thomas "All-Metal" Flexible Couplings to protect your equipment and extend the life of your machines.

UNDER LOAD and MISALIGNMENT only THOMAS FLEXIBLE COUPLINGS offer all these advantages:

- Freedom from Backlash
- Torsional Rigidity Free End Float
- Smooth Continuous Drive with Constant Rotational Velocity
- Visual Inspection while in Operation
 - Original Balance for Life
 - Unaffected by High or Low Temperatures
- No Lubrication
 No Wearing Parts · No Maintenance

Write for our New Engineering Catalog 60

THOMASSELEXIBLE

14

PRODUCT-DESIGN BRIEFS FROM DUREZ

- Something extra in molding compounds
- Fire-retardant structural plastic
- News notes for designers

Upgrading a product

Good • Plenty of distributor caps are molded of Durez general-purpose phenolic. When cost is a prime factor, general-purpose does the job and does it well.



Best • However, if you're shooting for something extra in a distributor cap (or in almost any electrical part), take a look at Durez 2271. This is an electrical-grade phenolic. A ½" test disk of it withstands 12 kv at 180°F in air for an hour or more without puncturing. The cost of this extra performance is low: weighing less than comparable electrical-grade materials, 2271 gives you more pieces per pound.



Good • You'd be right in choosing Durez 791 Black for a piece like this telephone handset. You'd be able to count on low molding cost because of 791's fast cure. You'd get the required physicals in good balance. And the price of this wood-flour-filled material is low.

Best • Then why do telephone men favor a different material, *Durez 17225*, for handsets? Because this wood-flour-

and-flock-filled material provides even higher resistance to impact fractures. The rich black finish presents an unyielding front to moisture and body acids. Bonus: a part that *more* than meets the specs—for fractions of a penny per piece.

We could go on and on giving you case histories like these. Have you looked into the extras you can build into a product—at next-to-invisible cost—with Durez molding materials? To get a better idea of what these compounds can do for you, send for our illustrated 8-page Bulletin D400 listing properties, uses, advantages.



CONSOLITE (CONSOLIDATED GENERAL PRODUCTS, INC.)

Safer skylight

Here's a plastic skylight that retards fire. It's made for use in hazardous locations or wherever building codes are exceptionally strict.

The material is fibrous-glass-reinforced Hetron[®]. It will ignite only under direct hot flame, and snuffs out as soon as the flame source is removed.

Weighing only half a pound per square foot, the skylight material will support a uniform load of 150 pounds per square foot. It is thermally stable from -65° to 200°F, and has great



On keeping abreast

How can a man keep up with all that's new in thermosetting plastics?

Well, it isn't easy. But we can help. We mail out every 60 days a bulletin, *Durez Plastics News*. You can read it in 10 minutes. It gives a bird's-eye view of what's new in the use of Durez plastics. Every item is *news*—hot off the presses of leading molders the country over, whom we visit regularly.

To get this bimonthly packet of ideas and information, just check the coupon.

strength and shatter resistance even at subzero temperatures.

Its thermal conductivity is only 1/s that of glass, yet it can transmit 1/s as much light as glass without glare. It delivers greater insulating effect than other skylight materials, at lower cost.

Could any of these attributes help you design a better product? Hetron[®] is hard at work already in radomes, chemical ducts, blowers, boat hulls, housings, fume hoods, window panels, canopies. Data on self-extinguishing Hetron resins is yours for the asking.

For more information on Durez materials mentioned above, check here:

- ☐ Phenolic molding compounds (8-page Bulletin D400).
- ☐ Hetron fire-retardant polyester resin (data file).
- Durez Plastics News (mailed bimonthly).

Check, clip, and mail to us with your name, title, company address.
(When requesting samples, please use business letterhead.)

DUREZ PLASTICS DIVISION

510 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION







by FAIRFIELD



GEAR PERFORMANCE to match the speed, size, and power of modern machines is a Fairfield specialty. This is possible because Fairfield is a leader in utilizing the most advanced methods, machines, and techniques for producing better gears. By keeping apace with modern engineering progress, Fairfield renders an invaluable service to many of the nation's leading machinery builders: "Gear Performance Made to Order!"

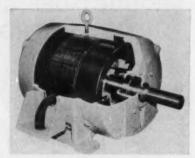
If you use gears in the product you make, we believe it will pay you, as it has others, to become acquainted with FAIRFIELD the place where fine gears are produced to meet your specifications EFFICIENTLY, ECONOMICALLY! Check with Fairfield NOW on your gear requirements. Call or

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TRACTORS . HEAVY DUTY TRUCKS . AGRICULTURAL MACHINERY . POWER SHOVELS AND CRANES MINING MACHINES . ROAD GRADERS . BUSES . STREET SWEEPERS . INDUSTRIAL LIFT TRUCKS



standard open motors, yet provide winding protection of enclosed motors at a lower cost. Line provides open-motor performance for applications usually requiring enclosed motors because of exposure to excessive heat, moisture, acids, gases, salts, alkalis, caustics, fine abrasives, shock, or vibration. They are available in NEMA designs A, B, C, and D for one, two, three, or four-speed constant or variable-torque operation in all standard voltages and frequencies. Howell Electric Motors Co., Howell, Mich.

Circle 816 on Page 19

DC Power Supplies

have self-protecting convection cooling

Precision-regulated, transistorized dc power supplies with improved circuitry and design reduce required components by 25 per cent. Convection cooling that is self-protecting and self-resetting provides lower preventive maintenance and quieter operation with no difference in noise level between on and off. Cooling fins form a chimney, when the units are stacked in a mounting rack, that sets in motion a natural draft to dissipate hot air. New circuit protects units against overloads, short circuits, misadjustments, and high line voltages. Elimination of variable autotransformers and relays has reduced weight and size of the units. Supplies are designed for laboratory, test, and original-equip-

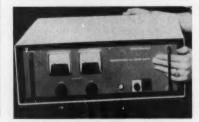




Photo courtesy of The Maytag Company

BETTER CASTINGS AT MAYTAG ATTRIBUTED TO ACHESON MOLD COATING PROPERTIES

Consistently uniform castings of gear housings for their entire line of automatic washers, have been achieved at The Maytag Company by the use of 'dag' 193 as a refractory mold coating. In their Newton, Iowa foundry, up to 2500 sets of gear housings and housing covers are produced in a three-shift work day. Since these aluminum housings have been designed to provide maintenance-free service over the lifetime of the washer, they receive permanent lubrication at the time of assembly. The protection of the gear train rests on the tightness of the housing . . . its ability to keep lubricant supply in, detergents and other contaminants out.

Uniformity was not easily achieved. The design of the housing and cover castings made it difficult to produce a part which was entirely free from shrinkage and surface defects. Wall thickness varies between ½" and ¾". Hot work tool steel, S.A.E. H-13, a non-heat treated alloy, was determined to be the best material for these permanent mold dies. The dies are pre-heated before applying the Acheson coating material. 'dag' 193 is diluted 1 to 3 with water for this application. It is sprayed on the mold surfaces during each shift with normal commercial equipment at line air pressure. During molding operations the dies are held at approximately 700°F., controlled with air and water. Pouring temperatures range from 1175°F to 1200°F. Sample castings are removed from the line periodically and checked for pressure tightness. Where additional protection is indicated, a touch-up coating is applied.

Because of its excellent insulating properties, 'dag' 193 minimizes shrinkage. The flow of molten aluminum and the degree of cooling is better controlled, even in those areas where the casting shape varies from thick to narrow. The continuous film of insulating particles spreads uniformly over the entire die surface, reaching critical areas to provide equalized insulation for all parts of the casting. Sound, trouble-free parts are the result at Maytag. Ease of parting is illustrated by the fact that the original H-13 steel die is still on the line after four years of use. Look into the application of a quality Acheson Dispersion in your permanent molding or casting operation. Send for Bulletin 425.

Product Design Aided By Acheson Dry-Film Lubricants

The continuing search for improved methods of designing and producing profitable — yet "abuse proof" appliances, has led a growing number of manufacturers to Acheson dryfilm lubricants. Two of the most popular of these products are 'dag' Dispersions 154 and 210.

'dag' 154 is a dispersion of colloidal graphite in isopropyl alcohol. This versatile material combines the fast air-drying quality of its volatile carrier, with the many inherent properties of colloidal graphite. These include low friction, long wear life, chemical inertness, and electrical and thermal conductivity properties. Because of its unique features, 'dag' 154 is providing permanent lubrication for internal mechanisms of toasters, washers, dryers, and other electrical appliances.

A companion product, 'dag' 210, is a dispersion of colloidal molybdenum disulfide in isopropyl alcohol. When diluted with compatible diluents, it may be applied by a variety of methods to form a quick-drying, tightly adherent MoS₂ film. This film exhibits the unique, high-pressure, high-temperature, lubricating and release properties inherent with molybdenum disulfide.

One of the most recent innovations has been the development of EMRALON® dispersions of tetra-fluoroethylene (TFE) in resin carriers. This permits, for the first time, the application of this unique polymer to a wide variety of heat sensitive substrates. The extremely low friction coefficient of TFE makes 'EMRALON' ideally suited for light load mechanisms.

There are many other applications of Acheson Dispersions in the appliance industry; one or more should prove profitable for you. For further information, write for our current Products List. Address Dept. MD-10.



'dag' and 'EMRALON', are trademarks registered in the U. S. Patent Office by Acheson Industries. Inc.





ACHESON Colloids Company PORT HURON, MICHIGAN

A division of Acheson Industries, Inc. Also Acheson Industries (Europe) Ltd. and affiliates, London, England

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DISPERSIONS



In short: Diamond CPA 1800 cuts your unit costs and saves you money. Diamond developed it. Your Diamond CPA 1800 Distributor can supply it where and when you need it.

For further information — call or write Diamond Alkali Company, 300 Union Commerce Building, Cleveland 14, Ohio.



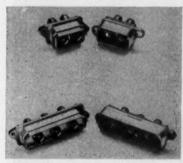
ment applications where there is a need for constant output regardless of the demand on the power supply. Units are available with output voltages ranging from 1.5 to 100 v in 30 standard designs. General Electric Co., Schenectady 5,

Circle 817 on Page 19

Rack and Panel Plugs

have improved coaxial inserts

DPNB, DPG, and DPJ Plugs and receptacles have improved one, two, and three coaxial inserts respectively. Refinements effect improved per-



formance characteristics in the area above 5000 mc. Inserts are special high-frequency, 50-ohm coaxial plugs and jacks developed to a high degree of electrical function. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Circle 818 on Page 18

Two-Part Adhesive

gives resilient bond at -40 to 185 F temperatures

Two-part adhesive is packaged in a small Saran tube which contains both base material and catalyst. Catalyst is contained in a small tube inside the larger tube. To mix, small tube is broken by squeezing and catalyst is kneaded into the base. After base and catalyst are mixed by repeated squeezing of the tube, end is snipped off and tube serves as the applicator. Adhesive, designated J1158, gives a resilient bond at -40 to +185 F temperatures. It has good tenacity and flexibility in holding materials such as metal-to-glass, metal-to-metal, plastic-to-glass, rubber - to - metal, rubber-to-glass, aluminum-to-alumi-



troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSH-INGS on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

Improve your product! Up-date your design and performance with Thomson BALL BUSHINGS!

Sliding linear motions are nearly always LOW FRICTION . ZERO SHAKE OR PLAY **ELIMINATE BINDING AND CHATTER** SOLVE SLIDING LUBRICATION PROBLEMS LONG LIFE · LASTING ALIGNMENT

> The vario " types cover a shaft diameter range of 1/2" to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.

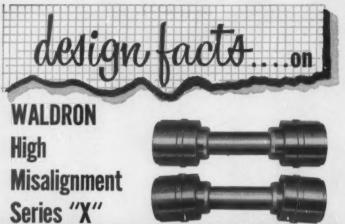


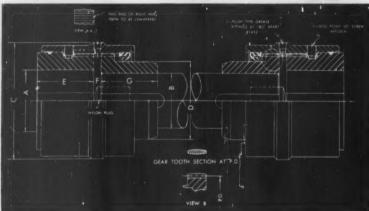
THOMSON INDUSTRIES. Inc.

Dept. E, MANHASSET, NEW YORK

Circle 578 on Page 19

Also Manufacturers of NYLINED Bearings ... Sleeve Bearings of DuPont Nylon, and 60 CASE . . . Hardened and Ground Steel Shafting





COUPLING	H.P. PER 100 R.P.M.	MAX. BORE RIGID HUB	MAX. BORE GEAR HUB B	с	D	E	F	G
11/4X	31/2	13%	11/4	3¾	2	21/6	1/4	2
2X	12	21/6	2	417/32	21/6	23/6	¥16	21/4
21/2X	26	2¾	21/2	5%16	3%	2¾	36	23/4
3X	50	31/4	3	611/32	41/4	31/4	7/16	31/4
31/2X	86	4	31/2	7%	5	3¾	7/16	3¾
4X	130	41/2	4 .	87/32	5¾	41/4	1/2	- 41/4
41/2X	210	51/4	41/2	97/16	61/2	434	1/2	434

The Series X coupling is specifically designed for transmission of power in applications where shaft misalignment is too great to be handled by a standard

gear coupling.

Each coupling assembly has two rigid hubs, mounted on drive shaft and driven shaft, each connected to a one piece sleeve by a spline used for driving purposes only. This spline extends only a portion of the hub length, and the remaining length of the hub is a turned surface which fits snugly into the counterbore in the sleeve to provide a suitable bearing surface. These two sleeves are connected by a floating shaft on both ends of which are mounted flexible hubs

with gear teeth of unique design which permits misalignment up to 5°.

Series X couplings are easy to dismantle and reassemble. By backing off the set screws, the sleeves can be disengaged from the rigid and flexible hubs. Specially designed seals and steel protecting rings are held in place in the sleeves with Spirolox rings. End portions of the gear hubs are tapered for easy reentry of the seal in reassembly.

All load carrying parts are machined

All load carrying parts are machined from high strength alloy steel. Floating shafts to customer specifications have nylon plugs inserted in each end to limit axial float and to prevent damage to the lathe centers of the roll shafts.

Write for Catalog



WALDRON-HARTIG D'VISION
MIDLAND-ROSS CORPORATION
BOX 791, NEW BRUNSWICK, N. J.
SALES REPRESENTATIVES FROM COAST TO COAST

num, and aluminum-to-glass. Industrial Div., Armstrong Cork Co., Lancaster, Pa.

Circle 819 on Page 19

Trimming Potentiometer

miniature unit weighs only 1 gram

Single-turn ultraminiature potentiometer which measures ½-in. in diameter and weighs only I gram is available specifically for transistor printed circuits. Single-turn adjustment in the Model 80 is from the



top, suitable for printed-circuit applications. In addition to advantages of humidity and moistureproofing, sealing allows unit to be encapsulated completely with other printed-circuit components. Potentiometer resists shock of 50 g and vibration of 30 g to 2000 cps. Spectrol Electronics Corp., 1704 S. Del Mar Ave., San Gabriel, Calif.

Circle 820 on Page 19

Air Valve

for sequencing and other automatic operations

Four-way, 1/4-in., five-ported, pilotoperated air valve is suitable for sequencing, remote control, and other automatic applications. It is capable of over 1000 cycles per min and has a high life expectancy. Small bleeder operator which features a hardened, ball-nose plunger can be mounted anywhere. Operator can be mounted so it will be tripped by the moving parts of machinery. It can also be used as a two-way, normally closed valve in other circuitry requirements. Valve operates at less than 5 psi line pressure. It is available as a double-bleeder (shown) for momentary operation



Modern steam-powered forging hammer

Vital fittings in refineries and chemical plants are forged, for only forgings can provide maximum strength required without excess weight. Fabrication is simpler, hanging and supporting are less expensive, life of fittings under severe operating conditions is extended.

The hammer-compacted metallurgical structure of forged parts gives superior performance in containing gases or liquids under high temperatures or pressures, vibration, high-velocity fluid flow and corrosion.

Design any vital parts to be forged ... strength/weight ratios are higher, as-assembled costs are lower, performance is better. Literature to help you design, specify, and procure forged parts will be sent on request.

When it's a vital part, design it to be FORGED



Drop Forging Association • Cleveland 13, Ohio

Names of sponsoring companies on request to this magazine

MANY FAST'S HAVE BEEN **WORKING LONGER THAN YOU**

It's a fact. There are plenty of cases where Fast's Couplings have been in service 20 to 40 years. And some of our more enthusiastic engineers say a Fast's should last forever if it's properly applied, installed and lubricated. Whatever opinion you accept, you can bet Fast's Couplings will give you the same smooth-running, lowmaintenance, long-lived performance that makes them the choice of more equipment manufacturers than any other gear-type coupling.

For example, Fast's Coupling No. 1347, shipped in July, 1922, is still in service-and the customer is just ordering his first spare coupling 38 years later. KOPPERS COMPANY, INC., 410 Scott Street, Baltimore 3, Md.

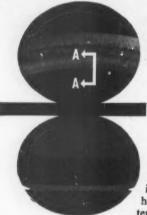


AST'S COUPLINGS

Engineered Products Sold with Service



Circle 581 on Page 19



TOP: Tool marks visible in TEFLON coating, magnified 12X,

BOTTOM: Section A-A TEFLON . . . conforms to irregularities in machined surface.

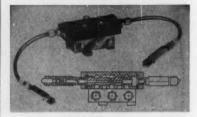
PERFECT SEAL ... Teflon* coating mates United's metallic O-ring to surface!

Teflon, permanently bonded to a United metallic O-ring, conforms to normal tool marks which it contacts in a machined seat. This remarkable, non-porous, pliable coating compresses into these irregularities to help form a perfect seal. Spring steel characteristics of the O-ring metal are retained, and the surface conformability of a rubber-like compound is added. Finish is completely non-corrosive and resistant to chemical action. Tests with gases and liquids, at high and low pressures, prove absolute sealing action. United also makes hollow tube; pressure-filled; and patented self-energized metallic O-rings; and wire and brazing O-rings to practically any required dimensions. Write for information (on your letterhead please).

*TEFLON IS THE REGISTERED TRADEMARK
FOR DUPONT TETRAFLUOROETHYLENE RESINS. | PATENTS 2, 809, 269; 2, 837, 360



NEW PARTS AND MATERIALS



or as a single-bleeder for maintained operation. Alkon Products Corp., 200 Central Ave., Hawthorne, N. J. Circle 821 on Page 19

Electroluminescent Panels

are flexible, bright units

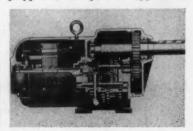
New electroluminescent panels have light output five times greater than other units now available. They are furnished in green, blue, yellow, and white. Panels are flexible, thin, and can be used in many applications. Electroluminescent lamps are available in sizes from 1 to 164 sq in. They are flexible plasticencapsulated panels only 0.030-in. thick. Miniature Lamp Dept., General Electric Co., Nela Park, Cleveland 12. Ohio.

Circle 822 on Page 19

Gearshift Drive

handles severe load requirements

Redesigned R3C gearshift drive is a 1 through 5-hp unit. Lower output shaft speeds are now available, capable of handling severe load re-Extra-heavy, alloyquirements. steel output shaft is mounted on widely spaced ball bearings to provide rigid support for extreme overhung loads. Four gear changes are made easily by means of a conveniently located gearshift lever, available in four optional positions. Shifting mechanism is positive and easy to operate. Unit operates on polyphase, ac power supplies of



SERVICES EXPANDED TO INCLUDE PRODUCTION OF

INSTRUMENT BEARING ASSEMBLIES

By RICHARD H. CHERWIN, Executive Vice President New Hampshire Ball Bearings, Inc.

New Hampshire Ball Bearings, Inc., has established a separate facility—the Rotassembly Division—for the manufacture of instrument bearing assemblies to customer specifications. Production of shafts, housings, and pulleys of various configurations your designs may require is also included in this newest of services to instrument makers. We believe our experience in the manufacture of miniature and instrument ball bearings makes this a logical expansion of our activities.

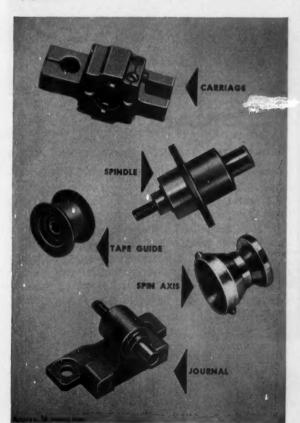
This new service can help you if you are having problems in any of these areas:

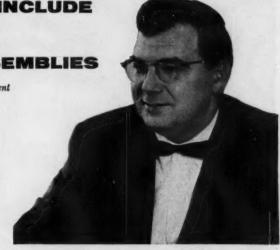
Purchasing and handling instrument ball bearings; Cost of assembling such bearings into units with proper fits; Cost of purchasing various components from separate sources with delays caused by un-co-ordinate deliveries;
Cost and difficulty of manufacturing components;

High rate of rejects and costly tear-down of assembled endproducts to correct failures.

FREE DESIGN STUDY AND COSTING

Activity here starts from designs submitted by you. Without obligation, experienced application and production engineers, also Division technicians, study your drawings with regard to these factors: Will the bearings function as required by the application? Can selection and mounting of the bearings be modified for better performance? Is the assembly a type and size compatible with NEW HAMPSHIRE's experience and equipment?





PRECISION MANUFACTURE

PRECISION MANUFACTURE

Instrument bearing assemblies accepted for manufacture are produced on the same types of precision machines that equip our Bearing Facility. Employing techniques developed to manufacture NEW HAMPSHIRE Bearings to ABEC Class 7 and better tolerances, components of your unit are ground to tolerances required for proper, easy assembly. Costly rework and refitting are eliminated. Competent technicians staffing the Rotassembly Division are thoroughly experienced in custom work in cost-lowering production quantities.

ASSEMBLY AND INSPECTION FOR TROUBLE-FREE PERFORMANCE

Assembly and inspection of instrument bearing assemblies are done on the same equipment used to process NEW HAMPSHIRE miniature and instrument ball bearings. In dustfree, temperature-controlled facilities, each component of your mechanical unit is critically inspected and tested before as-sembly, then the unit is functionally tested after assembly. Performance levels required of them are the same as for NEW HAMPSHIRE Bearings and fitting practices followed during assembly as outlined in the "Design & Purchasing Manual." Instrument bearing assemblies shipped to you are ready for installation into your products.

MANUFACTURE IS RESTRICTED

Manufacture is restricted to mechanical units in which correct installation and function of bearings are major critical elements in the performance of the assembled unit. We are not manufacturers of gears, gear trains, gear boxes, motors or electrical components and we are not qualified to produce these items. Relationship to instrument bearings is a primary qualification for all assemblies we elect to manufacture; it is in such types that our experience can best help you.

INQUIRIES INVITED

If you wish more information about the Rotassembly Division and our newest service to instrument makers - write or phone collect to the Regional Office in your area or the Main Plant in Peterborough.

WESTERN REGION 1540 North Highland Avenue Hollywood 28, California HOllywood 4-0208

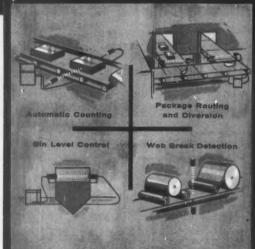
CENTRAL REGION 566 Northwest Highway Des Plaines, Illinois VAnderbilt 7-6646 EASTERN REGION 61 Cutter Mill Road freat Neck, New York HUnter 2-8633

NORTHEASTERN REGION
Route 202
Peterborough, New Hampshire
WAlnut 4-3311

NEW HAMPSHIRE

BALL BEARINGS, INC. PETERBOROUGH, N. H.







NON-CONTACT SENSING AND SWITCHING SYSTEM

Before Sonac, sensing and switching control systems which involved breaking a beam of energy were limited by vibration. dust, smoke, steam, air contamination and too much or too little light. Sonac's ultrasonic energy "beam" is completely free of these limitations. The acoustic lens on Sonac sensors can actually be painted without affecting performance. Utilizing high frequency sound also means there are no lamps to burn out. Savings in replacement parts and maintenance time often means Sonac pays for itself. Sonac is completely transistorized, providing you with a rugged, dependable electronic circuit.

These are just a few of Sonac's many uses. Optional equipment includes reflectors for precision beam and positioning control, and coupler assem-blies for use with flexible tubing for remote sensor locations. This descriptive booklet will be sent to you on





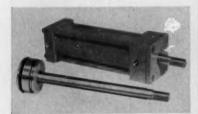
DELAVAN Manufacturing Company

standard frequencies and voltages below 600. Lima Electric Motor Co. Inc., Lima, Ohio.

Circle 823 on Page 19

Air and Hydraulic Cylinders

have one-piece aluminum piston



Low-cost air and low-pressure hydraulic cylinders, from 1½ to 3½-in. bore, are designated Cost Saver. Features include a one-piece aluminum piston, hard chrome-plated piston rod, aluminum end caps, seamless brass tube, block V-ring seals and wiper on rod and piston, and adjustable cushions either end. Available in flush, foot, front, and rear flange, clevis, or pivot mountings, cylinders are versatile and dependable on all fluid-power applications. Mo-Bar Hydraulics Co., Crystal Lake, Ill.

Circle 824 on Page 19

Pneumatic Timing Relay

adjusts over range of 0.2 to 60 sec

One-minute pneumatic timing relay incorporates a diaphragm assembly which eliminates the need for an exhaust valve. Timer maintains accuracy and reliability in dustiest environments through a self-cleaning filter system. Exhaust air is forced back through the intake filters to blow them free of dust which may have collected during intake. Adjustment screw takes seven complete turns to insure positive,



(Please turn to Page 290)



This giant drilling machine, engineered and manufactured by Michigan Special Machine Co., can drill 24 1-1/2" diameter holes in steel simultaneously. At each end of the shafts that connect the 24 individual drives and spindles is an Apex 3" diameter covered universal joint.

These 48 joints permit lateral movement of the spindles to conform to any desired drilling pattern. In addition, the *exclusive* Apex flexible cover provides clean, sustained lubrication that complements the automatic lubrication provided for the ways and other moving parts of the complete unit.

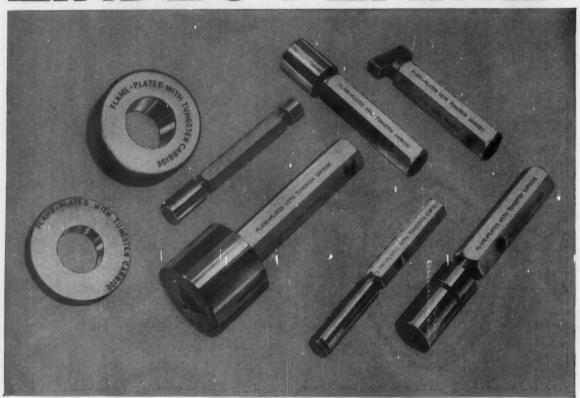
Apex heavy-duty universal joints combine size, strength and durability without sacrificing precision. Apex industrial universal joints, ½" to 4" diameter, covered or uncovered, are available in a full range of hub types and can be built to order from bronze alloys, stainless steels or other special materials required for specific types of service.



or write, on your company letterhead please, for Catalog 28 and Data Sheet. For special applications, send sketch or print for prompt recommendations and quotation.

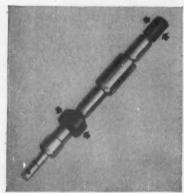


PRECISION PARTS GET TODAY'S LINDE'S FLAME-



GAGES—Superior wear resistance and other unique cost-saving advantages are exhibited by plug, ring, air, and specialty gages treated by

LINDE'S Flame-Plating. For example, Flame-Plated plug gages outwear solid carbide plug gages 3-to-1, and hard chrome-plated gages 20-to-1.



AIRCRAFT VALVES

Bearing surfaces of hot air valves used in the bleed air system of Lockheed's F-104A Starfighter must meet extreme conditions of wear and abrasion, also conditions of high unit loading and temperature extremes. Flame-Plating these surfaces with tungsten carbide solves the problem.



ALUMINUM ROCKER ARMS

One side of the "fin" of this important item in an aircraft engine heater mechanism actuates a lever and is subjected to severe wear. Before Flame-Plating, it lasted from 100 to 300 hours. Coating the wearing surface with tungsten carbide boosted service life to more than 1000 hours.



SEWING MACHINE FEED DOGS

LINDE's Flame-Plating has increased by more than six times the service life of the movable, serrated part that pushes material through the sewing machine. In this application, a .002-in. coating of tungsten carbide in ascoated condition provides both long wear and dependable gripping.

LONGEST SERVICE LIFE with PLATING

Gages and other components achieve remarkable resistance to wear when coated with tungsten carbide and other materials by LINDE's 6,000-degree, supersonic "weld-on" process...

NOW—many of the profit-consuming problems of metal wear and machine down-time have been eliminated.

With LINDE's Flame-Plating, gages, spindles, bushings, seals, mandrils, dies, core rods and other precision parts and components retain their precision and close tolerances for the *longest* period of time—under the toughest conditions of abrasion, erosion, corrosion, and high-temperature wear.

LINDE's exclusive service coats base metals with particles of ultra-hard materials, such as tungsten carbide and aluminum oxide—heated to plasticity by 6,000 degrees F. inside the Flame-Plating gun and then successively "fired" at 2,500 fps at the "target area."

The result is a tenacious, "welded-on" coating of approximately 125 micro-inches rms, which can be finished to the desired microinches rms.

NO WARPAGE-NO METALLURGICAL CHANGES

Despite the 6,000-degree temperature within the Flame-Plating gun, the temperature of the precision part or product being coated remains below 250 degrees F. This feature eliminates distortion and changes in the properties of base metals. Other features include low coefficient of friction and porosity of less than 1 per cent.

Wherever continuing precision and optimum wear are important factors, LINDE's revolutionary Flame-Plating gives amazingly longer service life... reduces production rejects...increases salvage value.

Find out how this coating service offered by the Linde Company can save on operating costs, make a good product even better, and improve over-all reliability. LINDE will provide a complete engineering analysis. List your possible applications in the coupon on the right and mail today for complete information.

COMPANY

Division of Union Carbide Corporation

LINDE and UNION CARBIDE

are trade-marks of Union Carbide Corporation.

UNION

FLAME-PLATING APPLICATIONS BEARINGS — sleeve, roller, gas

TYPICAL

BLADES — aircraft turbine; doctor blades for papermaking BLOCKS — anvil BUSHINGS — ball piston pump CHUCKS — seaming CUTLERY — household CUTTING, INDUSTRIAL — rubber, plastic, skiving knives, foods, paper, slitter knives, chipper knives, discontinuous chip-abrasive materials

DIES, TOOLING — cold-forming; coring punches, core rods, sizing punches, capstans

DOGS — sewing machine feed; gripping dogs

DRILLS – paper, acoustical tile, twist GAGES – plug, ring, air GUIDES – wire, textile, machine HYDRAULICS – pistons, liners, valve plates, wobble plates, metering

valves, servo valves, slippers MANDRILS — wire-forming PARTS — sintered PISTON RINGS

PLATES — valve, wear
SEALS — turbine engine, pump
SURGICAL — needle holders and shears
VALVES — aircraft

ZONE STATE

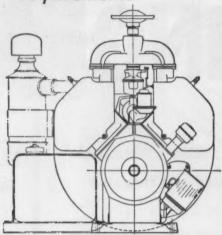
October 13, 1960

Circle 587 on Page 19

289

Let Wisconsin Engineers help you meet your power requirements

by modifying Wisconsin Engines to your individual needs with these



ENGINEERED ENGINEERED

accessory options

For every production-model Wisconsin Heavy-Duty Air-Cooled Engine — 3 through 56 hp. we offer a wide choice of assembly-ready modifications. These include, among other options: fuel and electrical systems, speed-regulation controls, power drive, fuel-tanks, and various other options.

But Wisconsin custom engineering goes beyond these options. Where your equipment operating and installation conditions require specialized engineering, our engineers will work with you to meet your needs most satisfactorily.

Here is a helpful service that can save you development time and experimental cost. More than 50 years of engine application and production experience are at your command.

Brief us on your power problem in terms of equipment and operating requirements. You'll find our seasoned counsel helpful and cordially cooperative.

Write today for Bulletin S-249, with condensed "specs" and general data covering the complete Wisconsin Engine line, Address: Dept. O-10.

ACCESSORY OPTIONS

FUEL SYSTEM — gasoline, natural gas, or LPG (for domestic use) and alcohol, kerosene, or No. 1 fuel oil (for export).

ELECTRICAL EQUIPMENT — electric starter-generator system or electric starter only for all models. Solenoid switches and automatic choke, for remote or automatic starting, also available.

NYDRAULIC POWER — all Wisconsin V4's can be equipped with integrally-mounted hydraulic pump.

POWER DRIVE—centrifugal clutch; over-center clutch; clutch reduction or reduction assembly in a variety of ratios; adaptor to take a spring-loaded clutch; or transmission-torque converter designs.

DIRECT DRIVE — special crankshaft extensions are available threaded, tapered, splined, special diameters and lengths, various keys, etc., for close-coupled pumps, generators, and other equipment.

SAFETY DEVICES — low-oil-pressure cut-off switch for 2- and 4-cyl, models, and high-temperature safety switch for all models.

OTHER ACCESSORIES — automotive and spark-arresting mufflers, pre-cleaners, drive pulleys for flywheel, rewind starters for ACN and BKN engines, and others.



(Continued from Page 287)

accurate adjustment over a range from 0.2 to 60 sec. Diaphragm is silicone rubber and operates dependably in temperatures from -45 to + 150 F. Cutler-Hammer, 328 N. 12th St., Milwaukee, Wis.

Circle 825 on Page 19

Photoelectric Counting System

has all elements in one package

PLS20 is a complete photoelectric counting system that needs only to be plugged into the line to operate. All necessary elements are contained in a single package measuring $2\frac{1}{2}$ x $3\frac{1}{2}$ x $6\frac{7}{8}$ in. Counter is driven directly from the transistor amplifier at rates to 600 per min. Light is



projected and returned to the photodetector via illustrated corner reflector. Gross misalignments and changing levels of ambient light have virtually no effect. Presin Co., 2014 Broadway, Santa Monica, Calif.

Circle 826 on Page 19

Static Adjustable-Speed Drive

is available in 1/20 to 3/4 hp

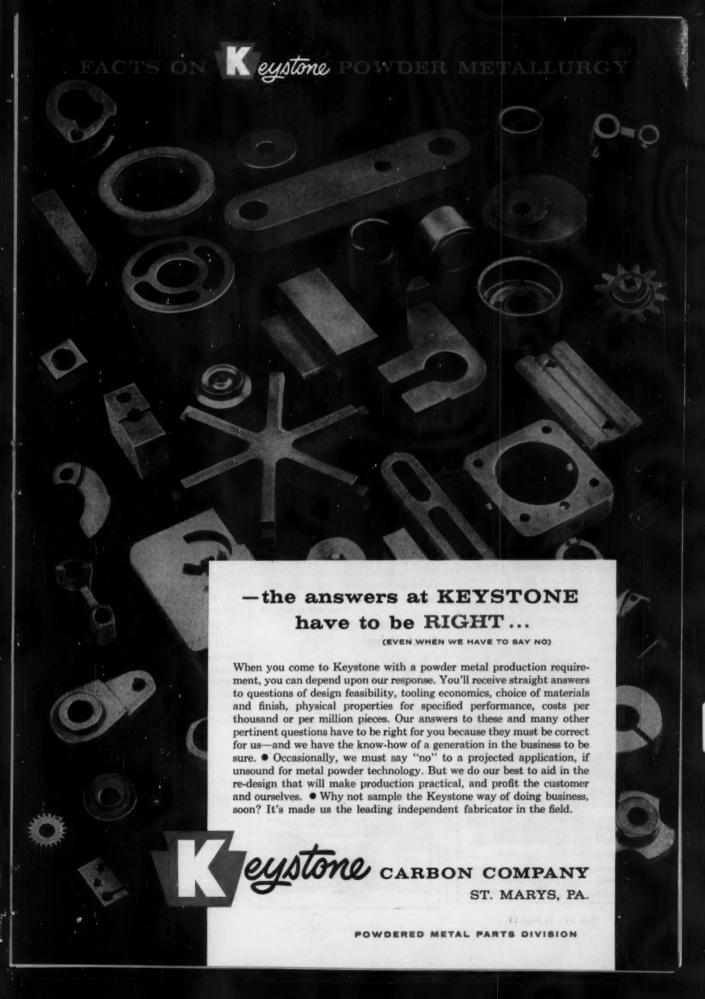
Statotrol static adjustable-speed drive is a fractional-horsepower device which is low in cost, compact and efficient. Control module combines a tiny, silicon-controlled rectifier and simplified, encapsulated circuitry. Module, along with a suitable potentiometer and disconnecting means, constitutes a complete control for starting, stopping, and adjusting the speed of a dc motor. Drive operates under extreme environmental conditions with a minimum of maintenance and is shock and vibration resistant. Unit is available in standard ratings from

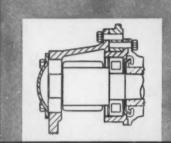


WISCONSIN MOTOR CORPORATION

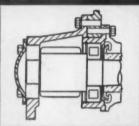
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

0-14





Conventional Tracing Paper DRAWING TIME... 2 hrs.



OGILVIE Tracing Media
DRAWING TIME...1 hr.

the big difference 1 hour saved!

Maximum quality—minimum drawing time . . . and it's impossible to tell which print was originally drawn on Ogilvie pre-printed tracing media. The big difference is the time saved. The hair-thin grid or guide lines disappear completely in reproduction . . . all that remains is your sharp clear print.

Ogilvie provides drafting efficiency by allowing rapid rendering to scale and by eliminating the need for constructing guide lines. And Ogilvie pre-printed papers stand the wear and tear of time because they're 100% rag.

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NEW PARTS AND MATERIALS



1/20 to 3/4 hp and has a standard speed range of 8:1. Designed for operation on a 115-v, 50/60-cycle, single-phase power supply, it can be operated from any standard voltage with a suitable transformer. General Electric Co., Schenectady 5, N. Y.

Circle 827 on Page 19

Antistick Agent

spray provides a low-friction dry film

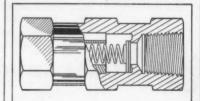
Rulon spray is an easy-to-apply, reinforced-fluorocarbon, slip and antistick agent. It provides a low-friction dry film which is chemically inert, insoluble, and thermally stable to over 500 F. Spray offers a fast, simple way to apply a slick surface for wood, metal, leather, and plastics. Resulting film is dry, nongummy and will not collect dust. Coefficients of friction as low as 0.07 are reported. Spray is ideal as a lubricant for belts, gaskets, packings, gears, bearings, cord, cable, machine parts, and conveyors. Dixon Corp., Bristol, R. I.

Circle 828 on Page 19

Check Valve

has burst pressure of 20,000 psi

Series 900 disc-type check valve with a one-piece body has a calculated burst pressure of 20,000 psi. Having no moving parts except a small disc, valve is unaffected by foreign matter. Opening pressure is 2-8 psi, and soft surface disc provides dead-tight sealing at all pres-



FROM DESIGN TO PRODUCTION LINE QUICKLY WITH



ALUMINUM and GREY IRON CASTINGS

Your design becomes a practical reality with superior castings from Gillett & Eaton, nationally known piston manufacturers. High alloy grey iron castings, aluminum and hypereutectic alloys in sand, semi-permanent or permanent mold. Complete pattern shop, tool room, x-ray and heat treating facilities, modern laboratory and piston machining facilities. Quality castings to your specifications—at a competitive price. Write for our quote.



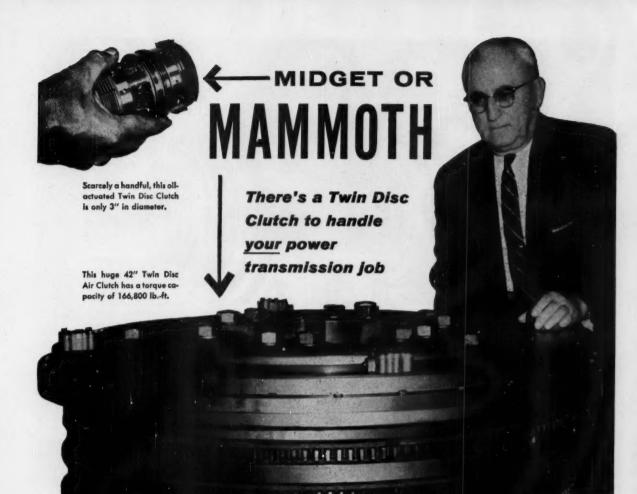
GILLETT & EATON, Inc.

860 Doughty Street, Lake City, Minn.

Sold in Canada by Gould National Batteries of Canada, Ltd. Fort Erie, Ontario

Piston and casting specialists

Established 1868





MECHANICAL

Small wet or dry clutches in 3.5" and 4.5" sizes with capacities to 14 hp. Enclosed units in sizes from 5.5" to 11.5" and capacities from 14 to 112 hp. Large heavy-duty clutches for high-torque duty; sizes to 36" and capacities to 1050 hp.



PNEUMATIC

Twin Disc Air Clutches provide more compact remote control without complicated linkage. Lighter weight reduces inertia mass, lessens shock loading during starting cycles. Sizes from 8" to 42" for every air-actuating application. Capacities from 29 to 1642 hp. Max. torque: 166,800 lb-ft.



HYDRAULIC

Oil-actuated multipleplate clutches for highspeed, high-energy operation. Compactly designed, readily adapted to push button control. Available with optional integral oil collector. Sizes from 3" to 7". Capacities to 137 hp and 690 lb-ft. of torque.



ELECTRIC

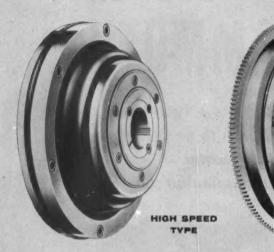
Direct-acting wet-type electro-magnetic clutches with stationary coils. Annular flux-through-plates magnetic principle provides high torque capacity and compact design. Compensates automatically for wear. Sizes range from 3.3" to 11.5" with torque ratings from 14.5 to 1812 lb-ft.

Send for Bulletin 314



This 20-page bulletin gives details and specifications on the com plete line of Twin Disc Friction and Fluid Drives. Write to TWIN DISC CLUTCH COM-PANY, Racine, Wis.

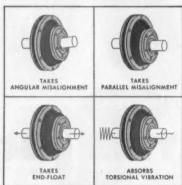




NOW! THE COUPLING WITH THE 4-WAY FLEX



THE 4-WAY FLEX OF PARA-FLEX



Para-flex

Industry asked for this—and here it is! Dodge Para-flex, the unique coupling that swallows up misalignment, is now available for high speed

FLYWHEEL

TYPE

applications, and for high torque at either high or low speed.

The new Dodge High Speed Para-flex is specially designed for operation with motors and internal combustion engines that turn up to 5230 rpm.

The new Flywheel Para-flex, with the same capabilities, has a flexing element that bolts directly to the flywheel of internal combustion engines.

Like the Standard Type (with capacities up to 2000 hp at 1080 rpm) these new Para-flex Couplings feature a modern, tire-like flexing element that handles angular and parallel misalignment, end-float (or any combination) and absorbs torsional vibration. The amazing performance of Para-flex Couplings is a matter of record in thousands of installations.

Ask your Dodge Distributor-or write us for new technical bulletin.

DODGE MANUFACTURING CORPORATION
3300 Union Street, Mishawaka, Indiana





CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the white pages of your telephone directory, or in the yellow pages under "Power Transmission Equipment."

sures in air, oil, and water. Unit is presently available in brass in 1/4, 3/8, and 1/2-in. female pipe. Bodnar & McDermott Mfg. Co., 19 Beechwood Ave., Mt. Vernon, N. Y.

Tempering Valve

is adjustable from 120 to 160 F

Low-priced tempering valve, No. 300, is adjustable to regulate water temperature from 120 to 160 F. Use of thermostatic power element



ensures positive operation. Two of the connections can be used with either ½-in. iron pipe or ½-in. copper tubing. **Dole Valve Co.**, 6207 Oakton, Morton Grove, Ill.

Circle 830 on Page 19

Aluminum-Impregnated Fabrics

resist heat to 2500 F

New process for impregnating any textile material or fabric with aluminum permits fabric to retain its original strength, texture, design, and flexibility while making the material heat resistant to 2500 F. Finish can be applied to one or both sides of a material, giving it an aluminum color or any other color desired, yet retaining the original texture. All types of treated material have a high degree of heat reflection and provide an extremely cold barrier. Safety Fabrics Div., Baxter, Kelly, & Faust Inc., C and Tioga Streets, Philadelphia 34, Pa. Circle 831 on Page 19

Stepping Switch

is compact and easily mounted

Type ACS stepping switch is designed for sequence controlling, counting and totalizing, scanning, information storage, and other



... Better still with new

MF Whiz-Locks

One-piece free spinners
that won't let go. So simple they'll amaze you.
So original there's a patent pending.

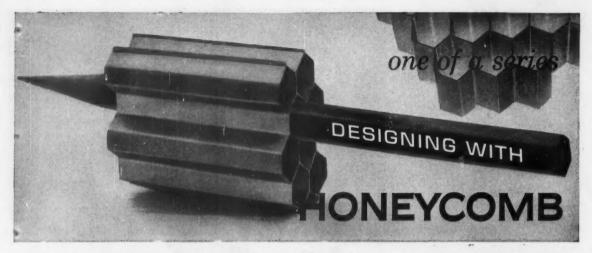


MacLean-Fogg's new Whiz-Lock is a one-piece, free-spinning lock nut that is simplicity itself. Spin it into place, wrench it tight and forget it. The scientifically designed spiral teeth take just the right grip on the work to prevent accidental loosening. Yet it removes readily on application of at least 25% more torque than was used to apply it.

MF Whiz-Locks have been as thoroughly tested as any new fastening device ever offered. Test them yourself soon. Samples are available free. Ask for hex nuts or bolts—with or without flange—in sizes from No. 6 to 38". State size desired.

SEND FOR SAMPLES





#8 HONEYCOMB AS A RADIO FREQUENCY NOISE FILTER

The use of metallic honeycomb in attenuating RF noise is an example of honeycomb's unique properties combining to provide several required end results. Honeycomb is extremely effective in this application, not only because of its ability to filter out radio frequency noise, but because it provides an extremely low pressure drop whether directionalizing air flow or merely serving as a grille. In other instances, honeycomb's RF filter properties combine with its light-directional or light-diffusing properties to place the sources of light in a well-lighted test room outside the electrically shielded area. Through correct choice of cell size and cell depth, all properties will operate near optimum levels.

Honeycomb at High and Low Frequencies

Two conditions may be critical in the attenuation of RF noise, although not usually in the same installation. The first concerns energy at the higher frequencies. Here, the cut-off frequency, or maximum frequency at which aluminum honeycomb will effectively block energy radiation, should be well above any frequency actually encountered. The cut-off frequency is a function of the cell size and cell depth of the honeycomb filter. Cell sizes are available in ¼ inch and % inch in visual-grade honeycomb and down to ½ inch in the less uniform structural grades, with cell depth as great as 24". In practice, the honeycomb most commonly used is a ¼-in. cell with a cell depth of ½" to 1".

The second critical condition of attenuation is at the low frequency end of the radio noise spectrum. In this area, choice of materials is more limited, since the shielding may require material of higher permeability, such as stainless steel or iron. Correct selection of material, cell size, cell depth and foil gauge, however, will assure effective frequency attenuation.

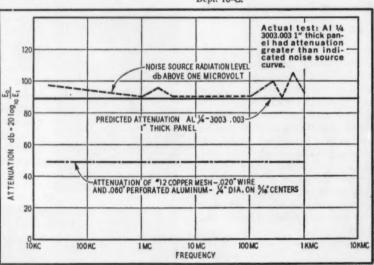
RF Shielding and Light Transmittal

Where light is to be transmitted through an RF shield, the honeycomb filter must first be able to perform its primary electrical function. For signaling devices, where a beam of parallel light is passed through the

honeycomb louver in a direction parallel to the cell axes, the correct combination of cell size and depth are not critical. For general illumination, however, in a full-lighted ceiling, the ratio of cell depth to cell size must be kept as low as possible, the honeycomb panel must be electrically grounded, and proper finish must be used on the cell walls. The light transmission properties of aluminum honeycomb are primarily a function of the cut-off angle (the angle whose tangent is the ratio of cell depth to cell size), relative position of the honeycomb at light sources, and the reflectance of the floor, walls, and ceiling.

As an example of honeycomb's light transmission properties, a typical Coefficient of Utilization (light transmission efficiency) for a large room would be about .40, assuming the installation of honeycomb with a cell depth of .433 in., cut-off angles of 60°, and optimum plenum conditions. A light level of 100 foot-candles with a Visual Comfort Index of 96 would be quite practicable in this installation. Increasing the cell depth would lower the Coefficient of Utilization, but would give an even higher Visual Comfort Index.

If your design problems could benefit from additional information about the RF shielding and light-directionalizing properties of honeycomb, send for TSB-112, "RF Shielding Properties of Metallic Honeycomb"; IILB-101, "Lighting Properties of Etched HONEYLITE"; and TSB-102, "Air Directional Properties of Honeycomb". Write Dept. 10-C.



Predicted and Actual Attenuation Test



Executive Offices: 2332 Fourth Street, Berkeley, California
Plants: Oakland and Berkeley, Calif.; Havre de Grace, Md.
Sales Offices: Long Island City, N. Y.; Chicago, Ill.; Fort Worth, Texas;
Inglewood, Calif.



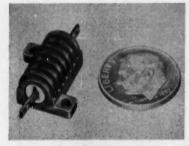
switching operations. Compact and easily mounted, it can be furnished with 2, 3, 4, 8, or 12 single-pole continuous rotation, for either shorting or nonshorting steps. Operating voltage is up to 230 v ac, with voltage range from -15 to +10 per cent of rated voltage. Nominal power is 20 v ac, minimum, and operating speed is 300 rpm. Rating is 1 amp at 115 v ac. Comar Electric Co., 3349 W. Addison St., Chicago 18, Ill.

Circle 832 on Page 19

Power Resistor

has maximum operating temperature of 275 C

Dalohm RH-5 wirewound precision power resistor is a 5-w unit sealed in silicone and inserted in a radiator-finned aluminum housing. Tiny resistor, which meets applicable paragraphs of MIL-R-18546B, is impervious to moisture and salt spray. Unit measures 0.600 x 0.334 in.



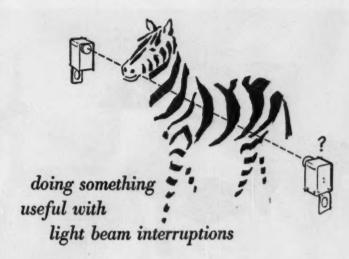
and has a resistance range from 0.5 ohm to 20,000 ohms. Maximum operating temperature is 275 C. Dale Products Inc., Box 136, Columbus, Neb.

Circle 833 on Page 19

Low-Pressure Cylinders

for air or hydraulic systems

Series A cylinders can be used



Our affiliate. The Fisher-Pierce Co., is in the photoelectric control business and began fooling around with CdS photocells as a replacement for phototubes some 6 or 7 years ago. We in turn are pretty well into the electromagnetic relay business, and have been tweaking springs and whiffing magnets for about 20 years. It shouldn't surprise a soul then to learn that we have a new line of photorelays, consisting very simply of the respective products living inside a little can. This is a new "line", which gives you a choice in the type of cell, relay contact arrangement, packaging and operation under on-off, slowly changing or high ambient light conditions. The 8RCO1A, for example, has a CdS cell, responds to "light - no light" conditions, switches 3 amp. 120 VAC resistive loads with SPDT contacts, and has an aluminum dust cover with plug-in base. If your machinery or control circuit is already built, you might be more interested in the complete "package deal" consisting of both photorelay receiver and light source, whose application requires bolting the units onto something and plugging in the line cord.

There are all sorts of things these photorelays can do for you, coupled with a

> small amount of ingenuity and 120 volts. They can act as the brains to prevent a

process or machine from grinding on if the feed is empty or the operator's hands are in the way, look at the level in a bin or column, or "measure" the level between set points; turn on inside lights in response to a night watchman's flashlight; switch display or sign lighting on at dusk, off at midnight, on again from 6 A. M. to dawn, in conjunction with a time switch (this ithe sort of thing in which Fisher-Pierce shines); and all the familiar counting, door-opening and 60-second hand-drying applications.

If you're interested in more exotic uses and have any hot nonincandescent bodies lying around, we can build you a special model with a cadmium selenide cell responsive to infrared rays (sources of infrared we cannot supply at the moment). Other non-standard possibilities include hermetically sealed units, special contact materials and units with low or high footcandle turn-on points.

Be not faint of heart if your application lies beyond the commonplace. One man of vision found success and happiness by using a Sigma Photorelay in his Chinese fortune cookie machine... with a little luck, you might be able to open a new frontier in light-beam-actuated swiss cheese manufacture. Bulletin with guiding specs on request.



SIGMA

SIGMA INSTRUMENTS, INC. 89 Pearl Street, So. Braintree 85, Mass.

AN AFFILIATE OF THE FIGHER-PIERCE CO. (Sixes 1995)



They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-86av.

DUCE NORTON COMPANY

Four Gateway Center · Pittsburgh 22, Pa.

DUFF-NORTON JACKS

Ratchet • Screw Hydraulic • Worm Gear



COFFING HOISTS

Ratchet Lever • Air Hand Chain • Electric



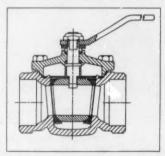
without modification in either air or hydraulic systems. Incorporating reverse trim packings and multiplelip rod wiper, interchangeable cylinder can be used for all types of industrial applications at pressures to 200 psi air and 500 psi oil or water. Cylinders are available in 21 different mounting styles and eleven bore sizes from 11/2 through 14 in., with strokes to specification. Piston seals and removable, cartridge-retained rod seals are rated for operation at temperatures from -20 to +150 F. S-P Mfg. Corp., 30201 Aurora Rd., Cleveland 39, Ohio.

Circle 834 on Page 19

Ball Valves

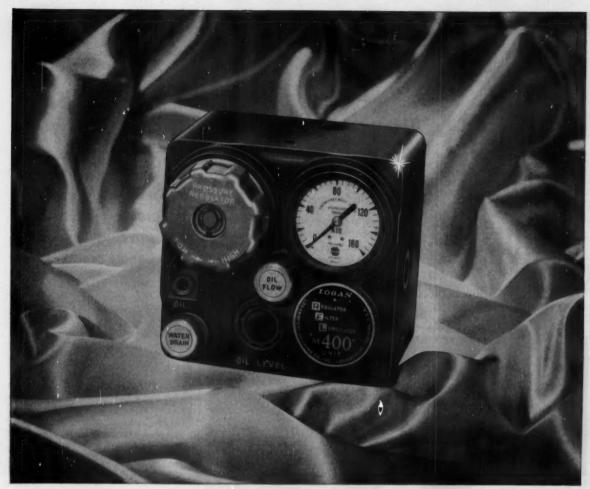
now have socket-weld connections

McCannaseal top-entry ball valves are now available with socket-weld connections in 1, 1½, 2, and 3-in. sizes. New design permits valve body to be permanently welded into pipeline. Access to valve parts is provided by a removable bonnet and stem assembly. Body materials are carbon steel or stainless steel, Type 316, and



seats are Teflon or Buna-N. Valves also feature fully self-adjusting ball seals and double back-seated stem seals. They control gases, liquids, slurries, semisolids, difficult-to-handle and corrosive chemicals at temperatures from -100 to +350 F. Hills-McCanna Co., 4600 W. Touhy Ave., Chicago, Ill.

Circle 835 on Page 19



Illustrated-Logan Model 400 RFL Unit

the ultimate in air čircuit

Logan RFL Unit, the designers choice for over a decade! Protects your air-powered equipment . . . regulates pressure . . . filters air . . . lubricates air. Adds years of dependable performance.

New Model 400, illustrated above, is a companion model to the well-known Model 600.



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LOGANSPORT MACHINE CO., INC. 811 CENTER AVENUE, LOGANSPORT, INDIANA PLEASE SEND COPY OF CATALOG: 100-1 AIR CYLINDERS 100-2 MILL-TYPE AIR CYLS. 100-3 AIR-DRAULIC CYLS. 200-1 HYD. POWER UNITS

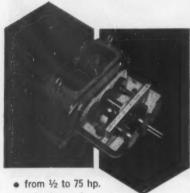
- ☐ 100-4 AIR VALVES
- 100-5 LOGANSQUARE
 CYLINDERS
 100-5-1 ULTRAMATION
 CYLINDERS
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- FACTS OF LIFE
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- output speed ranges: 0-100 to 0-7000 rpm
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These are just some of the outstanding characteristics of Specon variable speed drives. Rugged, reliable and requiring minimum maintenance, they permit infinitely fine adjustment of output speed with accuracies approaching fixed gearing. Specon drives also feature shockless starts and acceleration, full reversing, and provide output speeds up to 7000 rpm while maintaining zero speed features. Send for FREE data booklet on Specon variable speed drives.

STRATOS

BITISION OF PAIGCBILD ENGINE & AIRPLANE CORPORATION INDUSTRIAL PRODUCTS BRANCH #42, Route 189, West Babylon, N. Y.

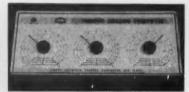
ENGINEERING DEPARTMENT

EQUIPMENT

Analog Computer Kit

demonstrates basic computer principles

Easy-to-operate analog computer kit demonstrates basic analog computing principles, and can be used for multiplication, division, powers and roots, and log operations. Unit is easily assembled with only a screwdriver and pliers, and operates on two flashlight batteries. Three po-



tentiometers and an electric meter are mounted on the die-cut box. Computer is 20 in, long, 9 in. wide, and 2 in, deep. Edmund Scientific Co., Barrington, N. I.

Circle 836 on Page 19

Pressure Transducer

produces high-level de output signal

No. 3S-G solid-state pressure transducer combines the best characteristics of both strain-gage and potentiometer-type transducers. It uses a semiconductor strain - gage sensor, possesses extraordinary accuracy and environmental capabilities, and produces a high-level de output signal that eliminates the need for impedance-matching or signal amplification. Unit responds to both static and high-frequency dynamic pressures. Transducer consists essentially of three modules, all contained in a rugged, anodized-aluminum case 11/8 in, in diam and 3 in, long. Transducer is extremely accurate, has better than ±0.1 per cent linearity and 0.1 per cent hysteresis over a temperature range of -65 to +250 F, and it has infinite resolution. Designed to meet MIL-E-5272B en-





To uphold its redoubtable reputation as a communications specialist, a leading manufacturer of automotive radio systems must be certain that every component used in its assemblies performs

For example, when this auto tuner assembly is coupled to the electrical sys-tem, it must provide positive location and low torque to ensure fine tuning... and dependable, precision-quality bearing balls perform a vital function. The bearing balls provide uniform torque between the conical shaft and the bearing race, without introducing tortional strain and undesirable angular displacement . and customer requirements for life expectancy and non-degradation in function of the complete assembly are repeatedly satisfied.

Abbott precision-quality bearing balls adapt easily, perform reliably, and last! A wide range of sizes is available. Write for complete information.



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RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities By Fred E. Graves

Fastening of "vibration" joints

With static assemblies, your only fastening worry is enough safe load capacity. But with dynamic loading, you also have to guard against loosening.

HIGH THREAD TENSION

You'll find one of the best locking mechanisms within the fastener itself: high thread tension. Obviously, the tighter the fastener, the higher the tension and the better the "lock."

CASE HISTORIES

(1) Textile looms notoriously suffer from vibration. Yet their bolts stay tight without any locking device when highly preloaded. (2) Heavy duty shakers had joint loosening problem which was solved for good when the maker switched to high strength hex bolts torqued up almost to yield strength.

Using split lock washers gives no such guarantee against loosening. It becomes equivalent to a solid washer at a relatively low load level. Once the screw has loosened to the point where the washer becomes a spring, it's too loose for safety.

When you can't fully utilize a high strength fastener, go to a bolt with prevailing torque lock nut; or to a unit that combines high thread tension along with a high off-torque value (such as RB&W's TENSILOCK fasteners—see Bulletin TL-2.)

With vibration joints involving thin gauge or sheet metal, it's better to use a thread-cutting screw, than a machine screw in tapped hole. It gives 100% depth of thread contact for more thread friction to resist backoff.

Some ideas for savings through cold forming



It generally costs less to cold-form a part than to machine it, since there's less scrap loss and more speed. The cold working strengthens the part, too—improves its physicals.

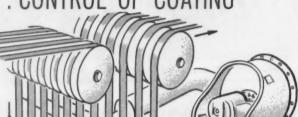
These four cases show what happened when designers and production men referred their needs in special parts to RB&W.

- Ball-head stud. Formerly produced on screw machine, this truck mirror pivot suffered high scrap loss, cost 75% more than it did when RB&W produced it by cold forming and some secondary machining.
- 2. Spacer. Cost of this automobile trunk hinge spacer was cut 50% when RB&W cold-formers took on the job of pounding them out at high speed, finely finished and ready for installation.
- Toper plug. Time and money were both saved by manufacturer of expansion bolts who came to RB&W to make these parts. Cold headers formed them faster than screw machines, and with zero scrap.
- 4. Adjustment cam. Cold forming affords the only economically feasible way to produce this part. Due to its large eccentric and hex end, machining and material costs would be excessive.

These examples typify a range of work from RB&W cold heading and cold forming facilities. RB&W also performs many secondary operations on parts to specification, such as drilling, slotting, knurling, etc. Best way to see whether you have a part that could cost you less is to refer it to RB&W for study. Write Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, New York.

Plants at: Part Chester, N. Y.; Coraopolis, Pa.; Rock Folls, Ill.; Los Angeles, Calif. Additional seles offices at: Ardmore (Phila.), Pa., Pittsburgh; Detrait: Chicago: Dallas; San Francisca.

The problem in planning production equipment at Stanley Steel Strapping CONTROL OF COATING





SPENCER BLOWERS

supplied the sensible solution



As a final operation in the finishing of steel strapping, it is necessary to lightly and evenly coat the strapping with wax. The obvious problem: how to control the amount of wax...specifically, how to prevent coating too heavily.

Incorporating a Spencer blower into the equipment solved the problem. Through a special nozzle arrangement, high volume, low pressure air is delivered against the strapping as it emerges from the final automatic dipping. Excess wax is blown off (and back into the tank) . . . thus reducing costly waste and providing precise quality control of the finished product.

Spencer will be glad to assist in adapting standard blowers —or developing special units—to meet *your* particular needs.

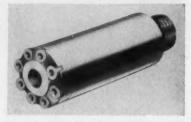


Request Catalog #126B containing complete specifications on Spencer blowers, available in standard capacities of:

⅓ to 1,000 H.P. Up to 20,000 C.F.M. 4 oz. to 10 lbs. pressure



ENGINEERING DEPT. EQUIPMENT



vironments, it withstands 50 g vibration to 2000 cps without damage. Components Div., Fairchild Controls Corp., 225 Park Ave., Hicksville, N. Y.

Circle 837 on Page 19

Diazo Whiteprinter

can be mounted on any office wall

Rotolite whiteprinter has finger-tip controls and fast whiteprinting lamp. New speed control does away with gear changing and unit makes sepias and foils as well as fast white prints. Single-lamp construction provides simplicity and low upkeep. Printing unit and transparent developing tube can be mounted on any office wall. Machine provides dry copies of anything printed, written, or drawn on transluscent material. Five models take any



length paper in widths of 18, 27, and 42 in. Rotolite Sales Corp., Stirling, N. J.

Circle 838 on Page 19

Portable Oscillograph

has five-speed pushbutton transmission

Type 5-124 portable, low-cost oscillograph has a five-speed, pushbutton-controlled transmission which provides record speeds of 0.25, 1, 4, 16, and 64 ips. Any speed can be selected while the motor is running without interrupting recording operation. Unit furnishes records by the print-out process and has a 200-



RIVETT... is the one source for the correct valve, to control all or part of any hydraulic circuit!

Whatever your requirements, you can find the right valve at Rivett. Save time, money, inventory and maintenance with these most advanced designs. Greater flow capacity; minimum pressure drop; positive damping and operating stability. From single basic assembly of functional valve any one of six functions may be obtained. Over 400

standard models—sub-plate and pipe mounted; direct control and functional. Pressures 1500 and 3000 P.S.I. All actions, all piston designs, all operations. Sizes ¼" to 2". J.I.C. standards.

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"Put ups" by the ALLOYIST* pay off in Production

There's a right kind of wire or strip "put up" for your production equipment... there's a right size or long runs and short runs. But, are you getting the kind and size of "put up" you need, when you need it?

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The ALLOYIST has them all...spools, reels and Pay-Off-Paks for wire in overlapping weights 25 to 1000 pounds...strip by coil weight to 2000 pounds or exact lengths...rod in exact lengths or randoms. Start the job right. Order your alloys from the ALLOYIST for a pay-off in smoother production.

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Riverside-Alloy Metal Division, H. K. Porter Company, Inc., Riverside, New Jersey.

RIVERSIDE-ALLOY



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ENGINEERING DEPT. EQUIPMENT



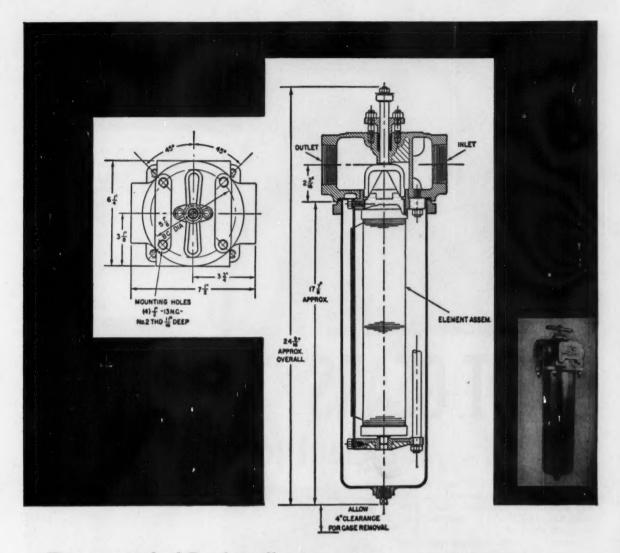
ft record capacity of 7-in, paper. Front access for loading, operating, and data viewing makes the instrument useful in rack-mounted installations. Constructed of modular components, it is 15 in. long, 13 in. wide, and 7% in. high. Writing speeds up to 50,000 ips are attainable. Oscillograph operates on a power source of 105-125 v, 50/60 cps, 500 w maximum. Electro Mechanical Instrument Div., Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Strain-Gage Accelerometer

measures accelerations perpendicular to surface

Small temperature - compensated, strain-gage accelerometer, Type 4-202, is a linear, unbonded, straingage bidirectional instrument, designed for measuring accelerations perpendicular to the mounting surface. Weighing less than 3 oz, the I cu-in. unit has linearity and hysteresis qualities conservatively rated at less than ±0.75 per cent of full range output. Nonpendulous mass suspension used permits exceptionally low cross-axis sensitivity. Damping is achieved by viscous oil shearing. Low-viscosity oil is used to keep viscosity changes to a minimum during low and high-temperature applications. Temperature compensation insures reliable static





This one standard Purolator filter is

EXACTLY RIGHT for all these fluids:

inks • paints • varnishes • food products • greases • process fluids • fuel and lube oils

SPECIFICATIONS: This Purolator filter model G-141J—is designed for filtration in a range upward of 40 microns.

It can be installed on pressure or suction side of pump. It is recommended for capacities of from 6 to 200 GPM, dependent on viscosity. Spacing varies from .0010 to .020.

Relief valves set from 10-12 (generally 15 to 20) to 50 PSI are incorporated in several models.

Motor driven knife blade to clean element can be furnished whenever conditions make manual rotation impractical.

Maximum pressure: 125 PSI; weight: 37 lbs. Equipped with simplex full-flow metal element oil strainers.

Available in all stainless steel construction for corrosive liquids, process fluids, food products.

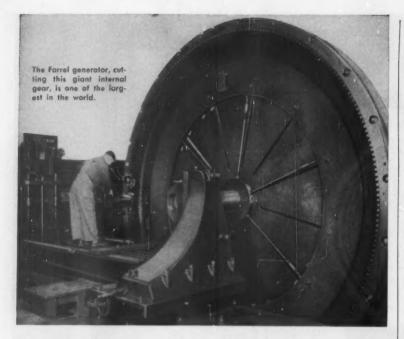
If this filter's specifications recommend it for a problem of yours, write for application information.

Filtration For Every Known Fluid

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GIANT GEARS for giant jobs

When designs call for huge gears, specify Farrel. The company has the experience and the gear-cutting and machining facilities to produce the largest gears required.

Farrel single-helical or spur gears are produced with generated teeth in sizes up to 23 feet diameter, 30 inches face. By alternate cutting methods this diameter limit can be greatly exceeded.

limit can be greatly exceeded.

Continuous-tooth herringbone gears are made in sizes up to 23 feet diameter, 60 inches face; internal gears, with single-helical or spur teeth, up to 23 feet external-blank diameter, 20 inches face.

Call Farrel on your next large gear requirement, Farrel engineers will analyze your problem and recommend gears suitable to your requirements.

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Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y. Sales Offices: Ansonia, Buffalo, Akron, Chicago, Minneapolis, Los Angeles, Salt Lake City, Tulsa, Houston, Atlanta

European Office: Piazza della Republica 32, Milano, Italy



This huge, 7-degree, single-helical gear will be used in a cement kiln.





FB-119

accuracy for -65 to +250 F temperature range. Standard range is ±5 to ±500 g. Over-acceleration up to 20 times the rated range is permitted by mechanical stops. Electrical-compensation chamber allows external adjustments for bridge balance, temperature compensation, and sensitivity. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 840 on Page 19

Direct Writer

is portable, two-channel unit



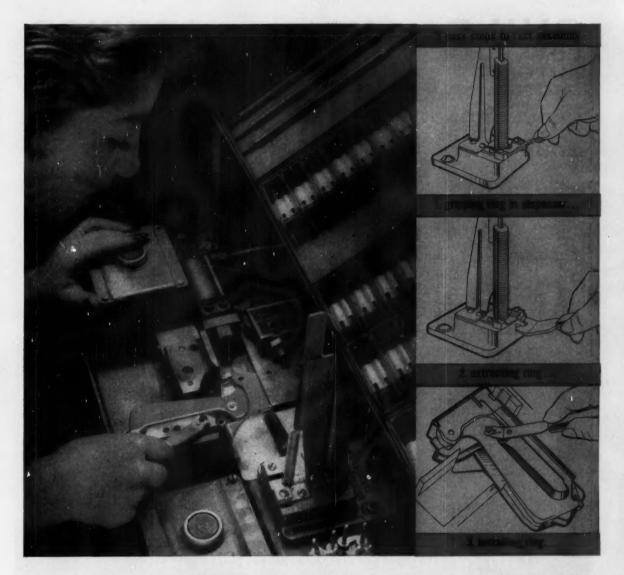
Two-channel oscillographic recorder with heated-stylus direct writing is housed completely in a portable case less than 1 cu ft in size. Model 320 system has two current-feedback amplifiers, each with floating and guarded inputs, and a rugged, twochannel recorder assembly with low impedance, enclosed galvanometers. Dependability and small size of the instrument are achieved through the use of completely transistorized circuitry. Instrument is set up so that the top panel is vertical, horizontal, or at a 20-deg angle using the carrying handle as a support. Unit has four pushbutton chart speeds and a marker-timer stylus with internal 1sec timer. Industrial Div., Sanborn Co., 175 Wyman St., Waltham 54, Mass.

Circle 841 on Page 19

Digital-Analog Converters

are transistorized, medium-speed units

Model 43 digital-analog converters which accept digital data in any of several forms are completely transistorized, medium-speed instru-



Truarc rings and dispenser speed staple gun assembly 60%

This big production increase was made by Swingline, Inc., Long Island City, N. Y. in assembling the handle lock of their high-compression staple gun.

To speed production, the Truarc Prong-Lock® Series 5139 retaining rings come pre-stacked for use on the Truarc dispenser (shown in foreground of photo above). Application is simple, fast and requires no skill. The operator, using the Truarc applicator, grasps the bottom ring, removes it from the stack, and installs it, quickly and easily, in the staple gun assembly.

The Truarc ring replaced an ordinary flat "C" washer, previously used in this application. While the unit cost of the washer was lower than that of the Truarc retaining ring, the use of the rings resulted in assembled cost savings of \$25.00 per thousand staple guns. The reasons: a 60% increase in production due to faster, easier assembly with Truarc tools, and the elimination of time-consuming, costly adjustments made possible by Truarc rings. What's more, the bowed Prong-Lock ring improved product design by providing resilient end-play take-up...eliminating looseness or binding in the parts.

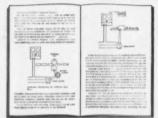
Truarc retaining rings come in 50 functionally different types...as many as 97 different sizes within a type...6 metal specifications and 13 finishes. Truarc assembly tools, pliers, applicators, dispensers and grooving tools are available to speed production of virtually every kind of product. Make sure you have on file the new 16-page Waldes Truarc Assembly Tool Catalog No. AT 10-58. Write for your copy today. And remember Waldes engineers are always ready to help you solve your special application problems. Waldes Kohinoor Inc., 47-16 Austel Place, Long Island City 1, N. Y.



TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

BUILD LOW-COST AUTOMATIC PROTECTION AND REGULATION INTO YOUR EQUIPMENTI

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Now there's a simple, inexpensive way to protect, regulate, and automate any electrically-powered equipment — from production machinery to conveyors and packaging systems. A designed-in Mek standard load control does it all, by sensing the telltale deviations in motor input current that warn of impending overload damage . . . excess speed, pressure, or torque . . . or human error.

Responding instantly to predetermined degrees of overload or underload, the Mek load control automatically initiates any desired action — stop, start, signal, index, reverse, change speed, compensate,

trip, or recycle.

With a built-in Mek load control, end-points can be established to control stamping, crushing, grinding, or mixing operations. Material feed rates, tool-to-work force, and conveyor operation are automatically regulated. Hundreds of mechanical functions now dependent on human alertness can be easily automated to protect equipment and material — increase production flow.

Send today for your free book of actual design applications. Learn how Mek load controls enable designers to build added performance and sales appeal into production equipment for metalworking, food processing, textiles, papermaking, and other industries.

MEK

Machinery Electrification, Inc. 64 Hudson St., Northboro, Mass. Circle 608 on Page 19 ENGINEERING DEPT. EQUIPMENT



ments. Output is a precision analog voltage proportional to the digital input. Any of the units can be used to drive a wide variety of voltagesensitive devices and, with additional circuitry, will drive x-y recorders. Compact, self - contained, rack-mounted units utilize printed-circuit techniques and modular plug-in assemblies. Front panel contains an illuminated display to indicate the contents of the storage registers for visual monitoring, testing, and calibration purposes. Over-all accuracy of the digital-to-analog conversion is better than ±0.10 per cent. F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.

Circle 842 on Page 19

Voltmeter

has voltage range of 1 my to 10 v

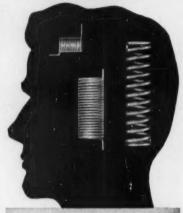
Model 411A voltmeter has seven 3.6 ranges, 1 mv to 10 v, and includes a db scale for readings from -42 to +33 db. Accuracy is ±3 per cent from 1 to 50 mc, and ±6 per cent from 50 to 150 mc. Five probe tips provide maximum useful-



ness for the voltmeter. Unit measures small voltages to 1000 mc with the convenience and accuracy associated with audio-frequency voltage measurement. It includes a linear scale for maximum resolution and high accuracy. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 843 on Page 19

SPRINGS ON YOUR MIND?



- Your next thought should be of the Spring Engineers at John Chatillon & Sons. Send them your blueprints and specifications for study and recommendation.
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- Next time, benefit by the thorough knowledge of Chatillon Spring Engineers. They'll be glad to help you. Send your blueprints to: Department D-2.





Alcoa's wizardry in machining aluminum and its alloys lets you write your own ticket for designing screw machine parts.

The Flo-Master Felt Tip Pen is just such a job. Its four pieces require 45 machining operations, 43 of which most machine shops could handle without blinking. But the two deep drillings of the 2½-in. cap and the 3½-in. barrel demand the special skills of extremely knowing hands—hands like those at Alcoa's shop in Lancaster, Pa. These adept hands also use eight different finishing operations to attain a colorful final finish that is highly attractive—unaffected by inks or ink solvents—and economical.

Whether it's screw machine products, forgings, castings, extrusions or impacts, Alcoa can put the metal

where you want it—precisely and economically. The payoff may be fewer rejects, new flexibility in design, less waste in production, a best-selling product—or all four. To draw on Alcoa's file of ideas and Alcoa facilities, write today: Aluminum Company of America, 905-K Alcoa Building, Pittsburgh 19, Pa.

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It's an all steel assembly with a pressure aided seal that can be quickly and easily disconnected. The seal ring is even re-usable! Yet, for all its sealing power, it's lightweight and small in size.

GRAYLOC pipe connections are manufactured in standard stock sizes from 1" to 30", but special sizes can be manufactured on request. They are also available made of corrosion resistant metals.

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Professional Viewpoints

. . . vehicle technology . . .

To the Editor:

Your various and excellent editorials on engineering education and Col. M. G. Bekker's series on "Mobility of Cross-Country Vehicles" prompted me to send you the attached notes on

Vehicle Technology and **Engineering Curricula**

The current revolution in American education includes re-examination of our engineering curricula. This discussion of one particular field, vehicle technology, emanates from studies at the Land Locomotion Laboratories of the Detroit Arsenal

General Definitions

Keeping in mind that fundamental rather than specialized studies are considered as the most important trends in any further development in education, a broad definition of vehicle and engineering should be formulated. Vehicle (from the Latin vehiculum, from vehere, to carry) means, according to Webster, a conveyance in or on which a person or thing is or may be carried from one place to another. Engineering translates science into practice.

It is generally acknowledged that increased teaching in mathematics and physics will become a prerequisite, with an early start in high schools. Similarly, humanities-including four years or more of at least one foreign language-fall under the same category, as recognized for centuries by most West-European and Russian high schools. Many of these basic studies should be transposed to our high schools, primarily for the more gifted students. This shift of courses which are being offered by the colleges would make room for other topics in our overcrowded engineering curricula.

In differentiating between basic and applied sciences, regardless how basic or applied are defined, some



In designing for air operation, the engineer can choose the method of valving he prefersand still have all the advantages of integral valve and cylinder construction.

Six different built-in valve arrangements give the engineer every latitude in pneumatic design.

If he prefers to use 8-12 volt electrical control with its simplified wiring, Bellows has it. If he prefers to use 115 volt control and JIC standards, Bellows has it. If he requires low or high voltage explosion-proof control, Bellows has it. Should his design require full pneumatic control, Bellows has it. Or should he wish to control his pneumatic circuits manually or through mechanical linkage or cams, Bellows has it.

Unlike conventional air cylinders which require separate remote directional and speed control valves and dual piping, the Bellows Air Motor is a complete power unit with directional valve and dual speed control valves built-in as an integral part of the unit. Only one air connection, which can be made with flexible hose, is required.

Integral valve and cylinder construction means quick response, more positive response, more precise control and more economical operation.

The Bellows Air Motor is made in five bore sizes: 11/4", 13/4", 21/2", 35/8", and 41/2", and in any stroke length.

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the complete line of Bellows Air Motors. Free on request. Address Dept. MD-1060, Bellows-Valvair, Akron 9, Ohio.

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DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)





Lubrite self-lubricating bearings offer great versatility in hundreds of fields where dependability and superior performance are of prime importance.

Lubrite Bearings, with clean, permanent, maintenance-free self-lubrication are designed to withstand severe loadings, temperature extremes, submersion, corrosion and other adverse conditions.

Lubrite may be just the bearing you need in your designs to obtain better results.

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LUBRITE DIVISION MERRIMAN BROS., INC.

188 AMORY STREET, BOSTON 30, MASSACHUSETTS

Circle 613 on Page 19

HUMAN-FACTORS ENGINEERING

by John D. Vandenberg and C. Thomas Goldsmith

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PROFESSIONAL VIEWPOINTS

words of caution might be in order. Knowing why (basic) means not necessarily knowing how (applied). For example, most drivers do know how to move their cars but not why their cars are moving.

Engineering requires both how and why, and overemphasizing one leads to poor results in any field of engineering.

The inherent dilemma is to find a compromise and neither overdevelop expertism by training narrow-minded specialists nor spread numerous topics too thin by covering irrelevant subjects.

Breaking Down of Curricula Barriers

From the previously mentioned broader definitions of vehicles, it follows that many of the artificial barriers still existing between the main conventional curricula (electrical engineering, civil engineering, mechanical engineering, etc.) must be torn down.

A separation between rail, highway, and cross-country transportation has to be de-emphasized, just as the differences between air and space vehicles (missiles) are disappearing rapidly.

From the military point of view, vehicle technology might stress cross-country locomotion, particularly mass transportation without the benefit of prepared roads (highways or rails), keeping in mind that preparedness for restricted-area conflicts seems to be just as important as readiness for intercontinental warfare.

The fact that the maximum velocity of present cross-country vehicles is about 20 mph, while running or leaping animals can reach up to 40 mph, may lead to other than wheel or track-supported carriers.

New Patterns and Subdivisions

Some of the various types of possible patterns referring to a generalized course of study in vehicle technology might be discussed. A common course sequence for all curricula during the first two years should remain, expanding mechanics in the broadest interpretation as a mainstay.

Furthermore, no attempt is made for subdivision into elementary and advanced sections. This might be equivalent to instructions on the undergraduate or the graduate level in case such a separation seems advisable. Graduate studies depend to a major extent upon the qualifications of the available instructors at each university.

Subjects Suggested for Vehicle Technology

General

: Elasticity Visco-elasticity Plasticity Vibration
Waves, Impact
Stress Analysis
Solid-State Technology

Hydraulics Flow Turbulence Waves Magneto-Fluid

Heat Transfer Mass Transfer Combustion Prime Movers

Combined Fields: Instrumentation Analogies Computers Automation Programming Communication

System Analysis

Supporting Media:
Soil: Soil-Dynamics (comprising Statics,
Kinematics, and Kinetics)

Mater: Hydrodynamics Air: Aerodynamics, Thermodynamics, Acoustics Space: Astronautics

Automobiles, Ships, Railroads, Airplanes, Space nctional Groups: Design Production

Testing Statistics Human Relationships

These rather heterogeneous and incomplete classification spectra are partially overlapping and should not be considered as a rigidly prescribed course sequence. They may, however, lead to a general and continuous pattern for the development of new curricula and indicate that not only the student but the instructor and the administrator have to be re-educated.

The late Dean H. P. Hammond, College of Engineering, The Pennsylvania State University, compared the educational process with a lathe, the instructor being the sharp edge of the cutting tool contacting the piece to be formed (i.e., the student), and hence representing the most important link. All other gears (administration) and power supply (financial agencies, etc.) should primarily provide the so-called "con-



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Co-operation with Other Agencies

Only two outstanding examples might be mentioned where vehicle technology as an engineering curriculum is introduced: The College of Engineering at the University of Michigan and its co-operation with the Detroit Arsenal, and the College of Engineering at the University of California and its Institute of Transportation and Traffic Engineering.

The exact designation of the type of curriculum as well as the name of the final degree granted to the student is irrelevant.

For graduate studies, including research, the universities are often handicapped by lack of funds to buy expensive equipment for laboratory or field experiments; military institutions may have the means to install facilities for special, urgently needed research projects.

The universities can be of substantial help by holding seminars, symposiums, conferences, etc., with graduate students, faculty members, and practicing engineers as participants and qualified specialists on the speakers' panel.

This co-operation of two types of mutually interested organizations appears to be most advantageous.

I would like to express my sincerest thanks to Col. M. G. Bekker, Director of the Land Locomotion Laboratories at the Detroit Arsenal for his much-appreciated assistance.

—R. K. Bernhard

Professor of Engineering Mechanics
Rutgers University
New Brunswick, N. J.

... preserving status ...

To the Editor:

Referring to your editorial, "Preserving Status," (Machine Design, Sept. 1, 1960) I would like to comment on the subject of value engineering, its objectives and function within industry.

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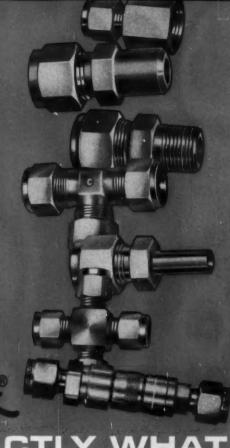
BORG-WARNER

Export Sales Borg-Warner International 36 So. Wabash, Chicago, III. ing into the term design engineer a variety of engineering functions. such as advance design engineering, product engineering, production engineering, and any other engineering activity with product responsibility. Of course, you recognize that the complexity of products, technology, and production techniques have necessitated specialization even within the engineering profession. Consequently, when you make the statement that the function of the design engineer is to translate ideas into hardware that can be sold at a profit, you are describing a broad range of responsibilities which are usually designated to several engineering groups.

Value engineers, to my knowledge, have never claimed decision-making responsibility in any one of these various engineering functions; but they have attempted to fill a gap which you yourself recognize as the design engineer's weakness in designing not only for performance, but also to accomplish the necessary function for the lowest possible total cost.

Definition

Value engineering is two thingsa package of techniques and a service function. Engineers who work in this service function should be trying to fill the above-mentioned gap by helping various design engineers make good use of the basic package of value engineering techniques. This is done by education in these fundamental techniques, consultation on design questions pertaining to costs and recommendations to the design engineer to help him decide on the lowest cost design alternate. It should be the objective of every truly professional value engineer to help build strong design-for-production capabilities within the engineering function. When the day comes that this need no longer exists, then there will be no need for the value engineering service function; but the package of techniques developed by good design, purchasing, and manufacturing practices should continue to serve all people with product design responsibility. This package was first identified, later developed, and finally taught by value analysts and the value engineering specialists to help meet



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—Frederick S. Sherwin Manager, Value Engineering and Analysis Services Raytheon Co. Waltham, Mass.

. . . the salaried professional . . .

To the Editor:

Charlie Balleisen certainly has a right to his views on what professionalism means to an engineer (Machine Design guest editorial, Sept. 15, 1960). He has given us a new slant on the old subject.

His philosophy, however, sort of "shakes" me in several areas:

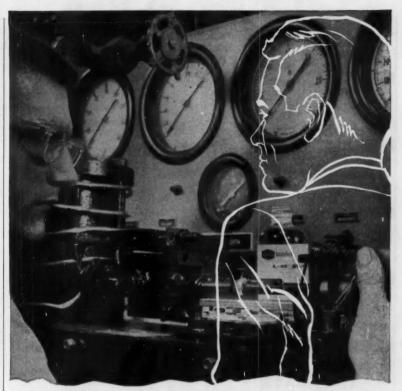
- The statement that he is employed because of his employer's ignorance (in a specific field) and this is what creates a relationship of trust and responsibility.
- The professional must always be "on the boss's side."
- Professionalism is the development of a reputation for keeping an agreement. Why, shucks, many clerks, brick layers, and mechanics have developed such a reputation.

May I submit that Charlie should look a bit deeper. The following may help:

Professional Responsibility In Engineering

Professional responsibility includes a level of competence. It includes thoughtful planning, judicious application of technical and scientific knowledge and experience to insure that the public welfare and safety are given proper consideration. It includes ethical practice and integrity. It embraces pride in workmanship and a humble willingness to share knowledge for the betterment of mankind. It includes an awareness that professional recognition depends on how a man accepts and carries out these responsibilities. Prestige is earned by the professional; it cannot be given to him.

-W. E. MESH Nichols, N. Y.



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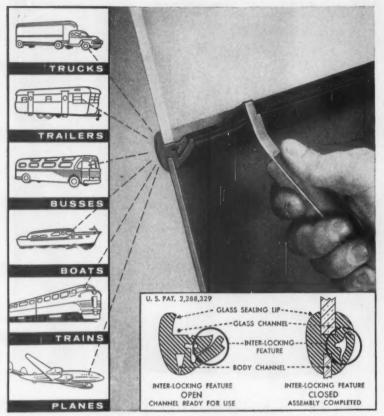


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Recent Books

Introduction to Mechanics, Matter, and Waves. By Uno Ingard and William L. Krausharr, Dept. of Physics, Massachusetts Institute of Technology; 672 pages, 61/4 by 91/2 in., clothbound; published by Addison-Wesley Publishing Co. Inc., Reading, Mass.; available from Machine Design, \$9.75 per copy postpaid.

Particular stress is placed on the basic concepts of mass, momentum, energy, angular momentum, and their conservation laws.

Collision experiments and conservation laws serve as the starting point and central theme in development of material. Then, from the study of momentum transfer during collisions, force is investigated as a dynamical concept.

Planetary motion and formulation of the universal law of gravitation from Kepler's laws are thoroughly covered. Mechanics of deformable bodies and waves is introduced through a study of what happens when a deformable body is given an impulse by an external force. Behavior of wave pulses, wavespeed, and energy content are explained through a combination of experiments and application of conservation of momentum.

Dictionary of Automatic Control. By Robert J. Bibbero; 282 pages, 5 by 7½ in., clothbound; published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.; available from Machine Design, \$6.00 per copy postpaid.

More than 500 expanded definitions of automatic-control terms are presented. Applications and related subjects are included in the definitions.

Control theory and basic concepts, computers and data processing, control components and design factors, industrial machine and process control, aircraft and missile control, and telemetering are covered.

Manual for Plastic Welding: Volume 3
—Polyvinyl Chloride. By G. Haim; 324

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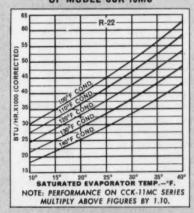
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pages, 53/4 by 81/2 in., clothbound; published by Chemical Publishing Co. Inc., 212 Fifth Ave., New York 10, N. Y.; available from Machine Design, \$15.00 per copy postpaid.

Development and applications of polyvinyl chloride (PVC) are discussed. Emphasis is placed on the welding and fabrication of PVC. Physical properties, commercial forms, manufacture, welding processes, and types of welds are discussed.

Foundations of Electromagnetic Theory. By John R. Reitz and Frederick J. Milford; 387 pages, 6½ by 9½ in., cloth-bound; published by Addison-Wesley Publishing Co. Inc., Reading, Mass.; available from Machine Design, \$8.75 per copy postpaid.

Basic experimental laws of electricity and magnetism are covered first. Then, a rigorous exposition of the fundamental theory is presented. A substantial number of example problems are analyzed.

Elementary atomic concepts are utilized in development of macroscopic theory. Physical approach is used in treatment of polarization and magnetization. Relation of microscopic and macroscopic concepts of electric and magnetic fields inside matter, and an introduction to plasm physics are also included.

Direct Conversion of Heat to Electricity. Edited by Joseph Kaye and John A. Welsh; 377 pages, 6 by 9½ in., clothbound; published by John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y.; available from Machine Design, \$8.75 per copy postpaid.

This collection of 23 papers contains fundamental discussions of thermocouples, vacuum and gaseous tubes, fuel cells, and magneto-hydrodynamic conversion. Practical applications and problems associated with each type of conversion scheme are considered.

Specific topics include an elementary design discussion of thermoelectric generation, quantitative design of a thermoelectric cooler, special techniques for measurement of thermoelectric properties, and thermodynamics of thermoelectric generators.

Polystyrene. By William C. Teach and George C. Kiessling: 176 pages, 51/4 by



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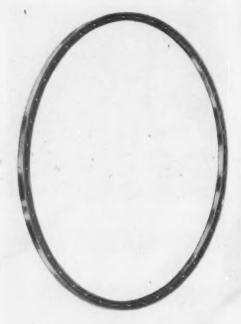
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71/2 in., clothbound; published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.; available from MACHINE Design, \$5.00 per copy postpaid.

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Recent information on uses of polystyrene in appliances, electronics, building, packaging, transportation, and toys and novelties is included.

Random Vibration. Edited by Stephen H. Crandall, professor of mechanical engineering, Massachusetts Institute of Technology; 423 pages, 6 by 91/4 in., clothbound; published by John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y.; available from Machine Design, \$8.50 per copy postpaid.

New concepts required to extend ordinary vibration theory into the field of random vibration are described. A broad picture is given of the current state of the art of designing and testing equipment which must withstand random vibration.

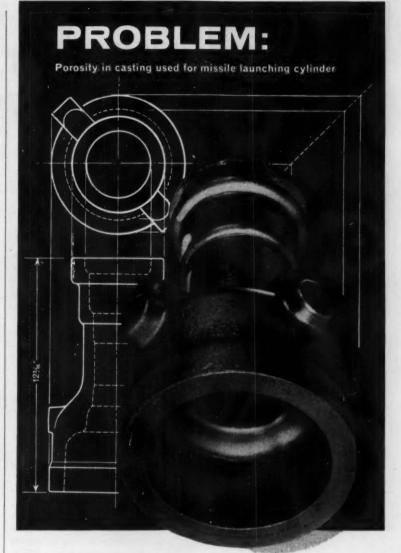
Material is divided into two parts. Basic concepts and background material are covered in the first section, and problems of design and testing are analyzed in the second section.

Association Publications

Friction and Wear in Machinery. 334 pages, 51/2 by 81/2 in., paperbound; published by and available from American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; \$7.50 per

Translated from Russian, this book contains 15 articles covering a wide range of topics-from hydrodynamic lubrication and bearing performance to boundary lubrication, dry friction, and wear. Specific topics include fundamentals of developing frictional brake materials, relaxation oscillations in elastic friction systems, and action of a sulfurized lubricant.

Pressure Vessel and Piping Design: Collected Papers, 1927-1959. 710 pages, 83/4 by 111/4 in., clothbound; published by and available from American Society of Mechanical Engineers, 29 West 39th St.,



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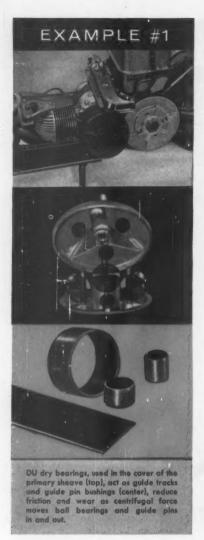
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Many papers which have contributed to the development of ASME Boiler and Pressure-Vessel Code and ASA Code for Pressure Piping are presented. Other papers have been included because they provide information about areas not specifically covered by the Codes. None of the material is supplemental to the Code requirements.

Some specific topics included in the 65 papers are gasket-loaded constants, stresses in pressure vessels, elements of joint design for welding, thermal stress, and data sheets for design of piping.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

PB 161152. Thermal Properties of Titanium and Titanium Alloys. By J. W. Holladay, Battelle Memorial Institute; 24 pages, 8% by 11 ln., paperbound, side-stapled; \$0.50 per

Orgy.

Properties covered include thermal expansion, thermal conductivity, heat capacity, thermal diffusivity, and emissivity. Methods are presented for estimating values of these properties when experimental data are not available.

PB 161413. Development of Molybdenum-Base Alloys. By M. Semchyahen, Gordon D. McArdle, and Robert Q. Berr. all from Climax Molybdenum Co. of Michigan; 138 pages, 8½ by 10% in., paperbound; \$2.75 per copy. Molybdenum-base alloys containing titanium and zirconium were subjected to various tests to determine their suitability for service at temperatures up to 2400 F. Tests included hardness, tensile strength, and creep-rupture strength.

PB 161436. Study of Methods for Nonde-structive Measurement of Residual Stress. By Fred R. Rollins, Midwest Research Institute; 41 pages, 8½ by 10½ in., paperbound, stapled; 51.25 per copy. Physical Phenomena exhibiting stress-de-pendent relationships were investigated to find new techniques for measuring residual stresses. A technique for measuring residual stresses. A technique for measuring the average stress through certain materials is described, and solves of error are discussed.

PB 161463. Sixth Materials Review. By Arthur Lyem, U. S. Army Chemical Warfare Laboratories; 92 pages. S by 10½ in., paperbound, side-stapled; \$2.25 per copy.

Research and development progress in high polymers and plastic materials are highlighted. Other categories include synthetic fibers, metals. and inorganic materials.

als. and inorganic materials.

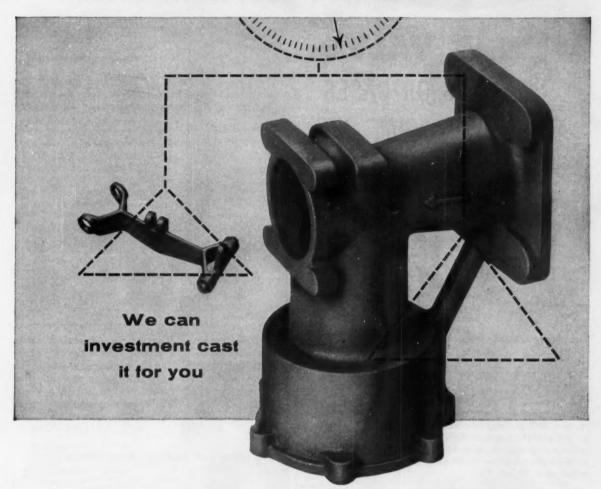
PB 16144. The Noises of Two-Spur-Gear Transmissions. 51 pages. 8 by 10½ In., paperbound, side-stapled; \$1.50 per copy.

Two conventional planetary genr trains were driven at speeds of 20,000 and 27,500 rpm with as much as 70 hp. Measurements were made of the total acoustic energy radiated, and also of unit intensities over the frequency spectrum 0 to 30,000 cps. From analysis of the test results, a law of acoustic energy was formulated for the two gear trains.

formulated for the two goar trains.

PB 161484, Study of Equipment Cooling
Systems. By Fred E. Schroeder, Edward E.
Towe, Phillip H. Lake, and Robert L. Wunderman, all from Boeing Airplane Co.; 165 pages,
8 by 10% in., paperbound, \$3.00 per copy.
This report contains the results of a study
of cooling systems for electronic equipment for
vehicles operating at velocities of Mach 8.0 to
20.0 at altitudes from 80,000 to 200,000 ft.
Expendable heat-sink materials, pressurization gases, heat-transport fluids, and several
simplified cooling systems are discussed. Effects on system weight of such things as compartment insulation, electric load, leakage,
flight time, equipment operating temperature,
and ground operations are shown.

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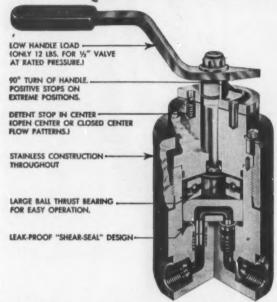
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Jarksdale valves

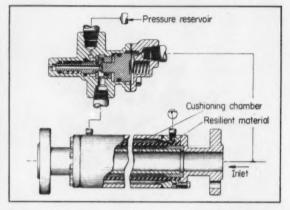
\$125 ALCOA AVENUE . LOS ANGELES 58 . CALIFORNIA

NOTEWORTHY

Patents

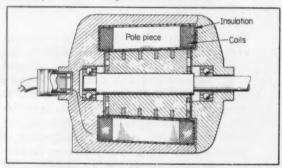
Surge Damper

Pipe line desurger of the perforated mandrel type uses a pressure-equalizing device to keep the pressure in the cushioning chamber substantially equal to the



line flow pressure. The pressure-equalizing device senses changes in flow pressures by a direct connection to the flow line, but its actuation to adjust the pressure in the cushioning chamber is provided from a pressure reservoir. Patent 2,949,932 assigned to Westinghouse Air Brake Co., Wilmerding, Pa. by Ellis E. Hewitt.

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Electrical motors of the induction type are made waterproof, explosion-proof, and capable of operation in elevated temperatures for extended periods by completely encasing the magnetic coils in a housing of ferromagnetic material. The housing material is formed of 95 to 98 per cent by weight of finely divided or discrete iron particles, coated with thin oxide insulation, and an epoxy heat-resistant resin to bond the particles together.

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Circle 631 on Page 19

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electric motors company Offices in principal cities . . . see YELLOW PAGES -to designers with special problems looking for GOOD IDEAS! . . the Howell

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Circle 632 on Page 19

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Copper Alloy Bulletin

BRIDGEPORT BRASS COMPANY



Bridgeport "CONTACT BRONZE" Cuts Costs of Electrical Spring Contacts by 25%

This outstanding Bridgeport alloy offers many of the superior mechanical qualities of phosphor bronze at considerably less cost... with a superior electrical conductivity rated at 22% IACS at 68° soft. Designed to meet the exacting standards of the electronics industry, Bridgeport "Contact Bronze" (Alloy 92) maintains spring properties even after difficult forming operations. Add corrosion resistance and "Contact Bronze" is a guarantee of efficient and reliable performance throughout your product's service life. Here are a few examples:

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The 100-hp 4-pole motors driving extruder-type machines in a dog-food plant were causing frequent production breakdowns. The material processed was so highly viscous that the motors were stalling, jogging and burning out. To meet the high torque. high slip necessary to minimize stalls and also to provide the high thermal capacity required, Allis-Chalmers Company designed a special motor rotor utilizing Bridgeport "Contact Bronze" in place of copper. Burnouts from overload were eliminated and the performance of the "Contact Bronze" motor was so excellent that Allis-Chalmers received an order for another sixteen of the same type.

TRAILER TRUCK BRAKING SYSTEM

Warner Electric Brake & Clutch Company manufactures an ingenious electric brake system for heavy-duty trailer trucks. Through a graduated series of Bridgeport "Contact Bronze" leaves, it allows the driver to adjust torque instantly and smoothly to suit load and road conditions. The conductivity and performance-proved spring properties of "Contact Bronze" provide added safety and long-haul reliability.



PRESSURE CLIPS



American Electric Switch Division, Clark Controller Company, found that "Contact Bronze" fitted their needs for a lower cost alloy for pressure clips. Its electrical conductivity, corrosion resistance, spring and formability properties were more than comparable with other alloys... at 25% less cost.

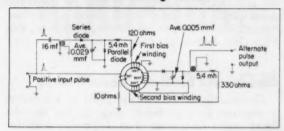
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conveying magnetic flux to all parts of the interior. The rotor is of unitary cage-type construction. Rotor bars extend parallel to the shaft and sets of end rotor bars extend toward the shaft. Both sets contribute toward shaft rotation. To achieve effective flux utilization, the ends of the rotor extend beyond the pole pieces to approximately the midpoints of the coils. Patent 2,950,401 assigned to Magna Power Motors Inc., Fullerton, Calif., by John M. Evans and Jimmie W. Luttrell.

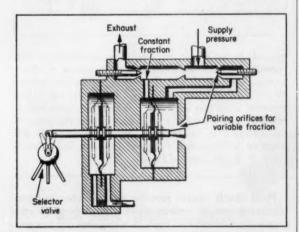
Scale-of-Two Pulse Counting Circuit



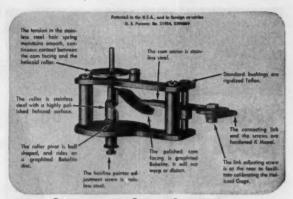
Compact scale-of-two pulse output circuit uses simple passive components—resistors, capacitors, diodes, and a single magnetic core with square hysteresis loop characteristics. Only every other input pulse causes an output pulse because of the simultaneous application of delayed pulses to the first and second bias windings. The circuit functions entirely from the energy of the applied pulses. Patent 2,949,542 assigned to General Dynamics Corp., Rochester, N. Y., by Neil L. Wiseman.

Fluid Actuated Toggle Mechanism

Two diaphragm-cylinder devices and two pairs of orifice-type pressure dividers comprise the components of a fluid toggle mechanism. Two fractions of the same supply pressure act on opposite faces of one diaphragm. The force associated with one fraction



is constant; that associated with the other varies with diaphragm position from less than to greater than the constant fraction. Two orifices, one of which is ad-



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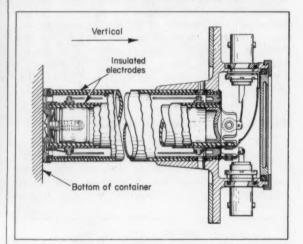


justable, function jointly to produce the constant fraction. Two others produce the variable fraction, resulting in the axial movements of the toggle mechanism control rod. The magnitude of the locking action is proportional to the constant fraction of the supply pressure. It is preset by adjustment of the needle-orifice member of the pair. The second diaphragm is a trip device. The pressures to activate this diaphragm are governed by differences between the pressures acting on the first diaphragm and a source of backpressures. As soon as a pressure differential signals and initiates a movement, the initial pressure difference that opposes the pressure signal decreases so that the diaphragm moves quickly from one off-center position to the other. Patent 2,948,116 assigned to the Marquardt Corp., Van Nuus, Calif. by Robert G. Olander.

3

Capacitor for Conductive Liquids

The quantity of a conductive liquid in a container is measured by a condenser using the fact that the liquid acts in the manner of an electrostatic shield between the electrodes. Concentric cylinders form a pair of insulated electrodes. Noninsulated wires between them are a third electrode, which is connected to



ground in a bridge circuit. Two condensers, two potentiometers, a transformer, and a source of alternating current comprise the rest of the bridge system. When the container is empty, the measuring device registers a certain capacity. When the container is filled with an electrically conductive liquid, the capacity measurement is substantially zero. Patent 2,950,426 assigned to Simmonds Precision Products Inc., Tarrytown, N. Y., by Leonard Frome.

Fluid clutch control provides dual clutches so interconnected that a predetermined force to engage one causes a predetermined force of engagement of the second. The force of engagement of the former can be increased but that on the second remains constant. Or, the two can be operated completely independent of each other. The control of dual winches is an application of Allhite 3

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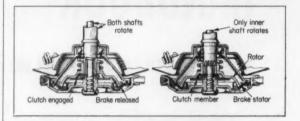
140-142 PARSONS AVE., COLUMBUS 15, OHIO

NOTEWORTHY PATENTS

the control system—one line is reeled in or out while the other is held fast, or the one is reeled at a variable speed while the other moves at some fixed speed. Patent 2,947,397 assigned to Bucyrus-Erie Co., South Milwaukee, Wis. by William C. Pietsch.

Concentric-Shafts Drive Assembly

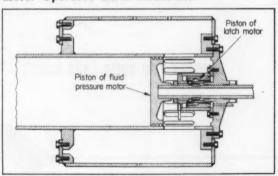
Two concentric shafts are driven by a reversible motor. In one direction of motor rotation, the inner shaft is driven while the outer shaft is held stationary by a braking device. In the opposite direction of motor



rotation, the inner shaft engages the outer shaft by a clutch and both rotate in unison. This engagement mechanism includes a helical movement to effect clutching and release of the brake for the outer shaft. Patent 2,948,372 assigned to the Maytag Co., Newton, Iowa, by John D. Goodlaxson.

Engine ignition distributor provides a control in which the curve plate is easily removed for replacement or recalibration and the vacuum advance is independent of the speed advance. Rotor registry is maintained at all engine speeds and vacuum even though the controls for the cam advances are independent. Patent 2,947,297 assigned to Holley Carburetor Co., Van Dyke, Mich. by Milton J. Kittler, Melvin F. Sterner, and Kalin S. Johnson.

Motor Operated Latch Mechanism



The position of a fluid pressure motor is controlled and latched by a double-acting, hydraulic, latch motor. In the latched state, the piston rod of the fluid pressure motor is held by a ball-stop device. The ballstop device, as shown, has the balls in the locked position with the piston of the latch motor displaced to





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Circle 640 on Page 19



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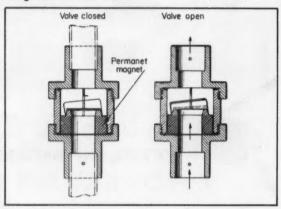
the right. Movement of the latch motor piston to the left unlocks the device by radial movement of the balls into an annular recess, thereby triggering the fluid pressure motor. Patent 2,949,889 assigned to the Bendix Corp. by Stephen G. Ivankovics and Garold R. Mikel.

*

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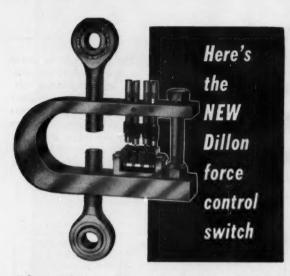
Supersonic centripetal compressor accomplishes compression by oblique, reflected, and normal shocks, singly or in combination, as well as by subsequent subsonic diffusion. Entering fluid at subsonic velocity is accelerated through a prerotation stage onto two contra-rotation stages at subsonic or supersonic velocities depending upon the type of compressor. One type which uses oblique and reflected shocks in both stages obtains the highest compression ratio at the highest thermodynamic efficiency. Another is a two-stage compressor having a stationary supersonic contra-prerotation stage and two supersonic compression stages that utilize oblique shock only. Other advantages accrue from additional types and modifications. Patent 2,949,224 assigned to American Machine & Foundry Co. by Vladimir H. Pavlecka.

Magnetic Check Valve



One-way check valve provides a nonmagnetic valve seat between the permanent magnet and the valve disc. The magnetic gap provided by the nonmagnetic seat reduces line surging and noise when the valve closes. The magnet and the seat are integral but the magnet is made from powdered or sintered permeable material, such as iron held together by a nonpermeable binder, while the seat is made of nonpermeable material alone. Guides restrain the magnitude of the movement of the disc relative to seat. Patent 2,949,931 assigned to Hughes Aircraft Co., Culver City, Calif. by Siegfried Ruppright.

Temperature-compensating indicator, particularly electric wave meters, utilizes a spiral scale and a movable index line. The pivot point of the index line is offset from the center of dial rotation; hence, different angular amounts of dial compensation are achieved at different portions of the spiral. A bimetallic temperature



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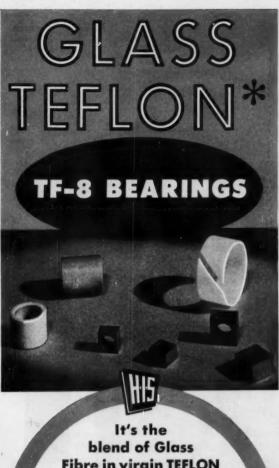
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Circle 642 on Page 19



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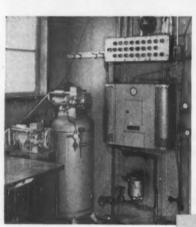
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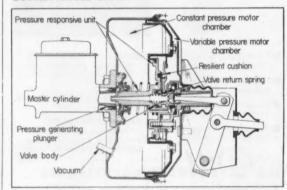
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NOTEWORTHY PATENTS

compensating element causes the index line to rotate about its pivot in response to differences in temperatures. Both the position of the index-line pivot relative to the center of the spiral scale and the rotation of the index line in response to temperature variation contribute toward correcting and minimizing the errors from temperature variations over the range of the instrument. Patent 2,949,881 assigned to Polytechnic Research & Development Co. Inc., Brooklyn, by Christian D. Berger.

Booster Brake Motor



Radial reaction levers and a pressure responsive unit on a motor vehicle brake provide cushioning of the initial pedal movement and delay in experiencing full brake pedal reactions until a predetermined pressure has been built up in the master cylinder. Initial movement of the brake pedal encounters little reaction because of the slight resistance afforded by the resilient cushion and the valve return spring. This initial movement also closes the valve between the constant and variable pressure motor chambers. Further movement of the pedal opens a valve to admit air at atmospheric pressure to the variable pressure motor chamber. The unbalance in pressures shifts the pressure-responsive unit to the left and actuates the pressure generating plunged in the master cylinder. Patent 2,949,892 assigned to Kelsey-Hayes Co., Detroit, by David T. Ayers Ir.

Temperature detection and measurement under different environments and over wide ranges of temperatures is based upon the dielectric sensitivities of various compounds. For instance, the resistance and capacitance of lead zirconate are sensitive to temperature and can be used for a two-signal system. The resistance diminishes linearly with increase in temperature up to 400 F while the capacitance is approximately constant. Near the Curie point (448 F) the capacitance increases abruptly. Thus, the resistance sensitivity can be used for temperature measurements below 400 F whereas the capacitance sensitivity can be used as a warning signal for over heating. Patent 2,949,594 assigned to Sperry Rand Corp., Great Neck, N. Y. by Alben J. Tava, James S. Adams, and Robert C. Van Aken.



On-the-job proof at BLACK & DECKER

Spiroid gears are used in the Black & Decker "Shorty" electric drill to deliver the desired right angle drive at a ratio and size not practical with bevel gears. Excessive heat generation, a problem of worm gears, is eliminated by the use of Spiroid gears. The unique "Shorty" permits drilling holes in confined spaces. It is lightweight, small, easy to use ... an excellent tool for electrical installations.

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To get the full story of Spiroid gear strength, shock resistance, space and weight savings as well as their manufacturing and assembly versatility, send for your free file, "Low cost design begins with Spiroid's family of modern gears." Booklets on Planoid® and Helicon® gears will be included.



Spiroid gears are used to rotate each of the three lead screws controlling the axes of the Kearney and Trecker "Milwaukee-matic", an automatic, tape controlled unit that can drill, bore and mill. Spiroid gears were selected because they can handle the required heavy torques at near zero backlash—a must for machine repeatability.





Spiroid* gears

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On-the-job proof at NATIONAL CASH REGISTER

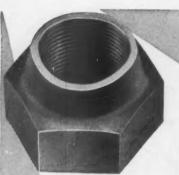
Economical, space-saving Spiroid gears are used by the National Cash Register Company in their Class 61 model to permit the use of a slightly larger induction drive motor to gain the benefit of service-free performance. Spiroid gears replaced a set of worm gears permitting the more dependable power source with no increase in overall cash register size. The Spiroid pinion is rolled on the and of the motor shaft.



On-the-job proof at WEBCOR, INC.

Webcor, Inc., in a classified Government project, uses Spirold gears for a unique tuning drive. No other system can provide the combined efficiency and high ratio required in a single gear-set. Spirold gears eliminated a complex series of spur and bevel gears previously used Note particularly Webcor's Interesting use of spur gear teeth on the O.D. of the Spirold gears providing two gear functions with a single part

Circle 646 on Page 19



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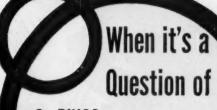
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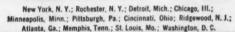
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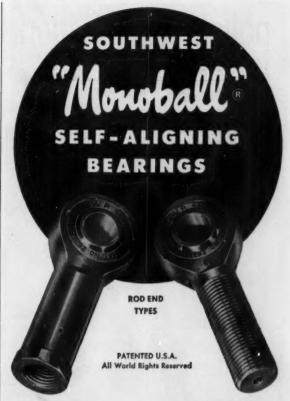
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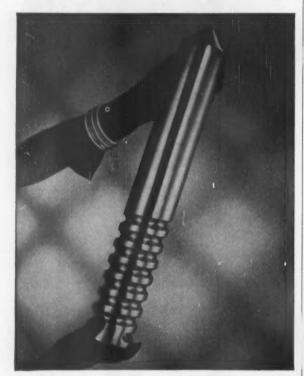
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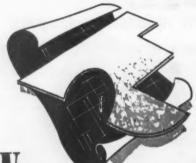




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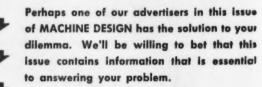


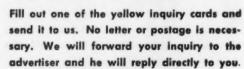
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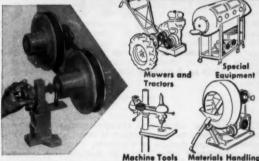
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backtalk-

-Two New Hands

Those of you who read our editorial masthead regularly must have noticed the two new names in this issue. Joseph Homitch and Francis Lavoie joined the staff of MACHINE DESIGN the same day.



Fran comes from Fort Wayne, Ind., where he was a field service engineer for the Weatherhead Co. This job, essentially that of a troubleshooter, took him all over the country.

A graduate of Indiana Technical College, Fran is the only aeronautical engineer we know who doesn't like to fly. (Tried it once and didn't like it.) He prefers to travel a little closer to the ground in his Porsche. A real sports car addict, he used to race a Jaguar.

Less dangerous avocations include fencing, which he did in college, attending operas and symphony concerts, and—the universal writer's hobby—reading.



Joe made almost a transcontinental trip to join the Machine Design staff. A Seattle Washingtonian, he formerly worked at Boeing Airplane Co. His first job there, right after high school, was a rivet bucker. He admired the engineers, and after military service, went to the University of Washington, earned a B.S. in electrical engineering, and came back to Boeing as an engineering aide. He advanced to the job of engineering writer.

During his high school career, Joe was a ham radio operator, and he pursued this interest in MARS (Military Amateur Radio Service) while he was in the Air Force. Now he is content to just sit there and listen to his hi-fi set. He also plays a little golf and bowls in the Penton league.

Fran edits articles and is responsible for Tips and Techniques; Joe has joined the team which produced our Fasteners Book and is now working on the Seals Book.

-Accent on Accents

Machine Design's annual new-car roundup, divided between this issue and the last one, attracts a good deal of attention, which we modestly attribute to its comprehensiveness. However, since even two such fact-packed articles can't tell all things about all cars, we have here some more information you will want before choosing your '61 model.

Chrysler has an electric pushbutton windshield washer. A motor-driven positive-displacement pump squirts four jets of washer fluid when the button is pushed.

In Ambassador's four-door locking system, servo units in each door are controlled by a switch on the dash. The driver must be seated to make the locks work.

Cadillac's 1961 air-conditioning and heating systems can be used simultaneously to cool the top level and warm the cold-feet area.

Ford decided the best place to mount the Thunderbird's rear-view mirror is on the windshield, so that's where it is, stuck on by a vinyl lamination process.

The Lincoln Continental, with all its other fine attributes, has an economy feature: Oil needs changing only every 6000 miles.

—No Bongo Playin' Here

If you look like the fellow on Page 49, please don't pay any attention to Page 318.

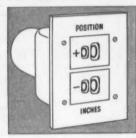
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Veeder-Root READOUT Bulletin

Readout Counter used in Tape Preparation for Machine Tool Control

A Veeder-Root Series 1538 Remote Data Readout Counter provides tape feed control for the motorized tape punching unit of the new Potter & Johnston Tape Control System. The tape punch is used to program machine functions on P & J Automatic Turret Lathes. The counter automatically controls the amount of tape feed required for each turret face involved, and stops the tape at preselected address points. When the correct address point is reached, a combination of holes representing the machine command is punched into the tape. Counter is automatically reset for each turret face.



Servo Repeaters Drive Counters to Indicate Lineal Motion*

One of the ways to take advantage of digital readout for indicating and

recording information at remote points is through servo repeaters. Applications in aircraft, for altimeters, navigational displays and similar instrumentation, suggest many other opportunities to use counters for more positive indication and control. A typical "system" is shown here where a counter is used for indicating nuclear reactor rod position. The servo repeater and counter actually form one

packaged unit, and the whole device can be potted for environmental protection. When used to drive counters, the servo gear ratio is best selected to provide full scale travel of the counter for one revolution of the control transformer shaft.

Typical servo repeater/counter device that converts synchro data to digital readout.

Output shaft to counter

Let Veeder-Root help you make Counters do more? Extensive design experience and precision production techniques make it possible for Veeder-Root to help you solve a wide variety of digital, readout, control and recording problems with counters — from the simplest ratchet to advanced readout and navigational devices. Send for information on specific applications or contact your local Veeder-Root Counting Engineer.

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Veeder-Root Readout Device This is the basic series of Remote Data Readout

This is the basic series of Remote Data Readout Counters. Some are available for standard applications, or design variations will be submitted based on requirements. They function basically as analog to digital converters.

Series 1538/electrical reset/ electrically actuated. Speed 1000 cpm, 3 or 5 figure



Series 1538/electrically actuated/ manual reset. Speed 1000 cpm, 3 or 5 figure

Series 1606/mechanically actuated manureset standard; bi-directional (non-reset) available. Speed 5000 cpm, up to 5 figures



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Farval cuts downtime on automatic plating machine

Quantity production is a prime purpose for automatic machines such as this Stevens plater. Bearing failure, long the enemy of automatic processes, is eliminated on this plating machine at a prominent Midwestern automotive parts plant through application of a Farval lubrication system. Downtime for repair of bearings is virtually eliminated.

FARVAL— Studies in Centralized Lubrication No. 229

This Farval system provides measured amounts of lubricant to each bearing at regular intervals. Large ports on Farval systems insure adequate lubrication without dangerous line pressure loss or grease separation.

Learn how you can cut downtime with an application of a Farval system to your process or machinery. Ask for revised Bulletin 26-T. Write...

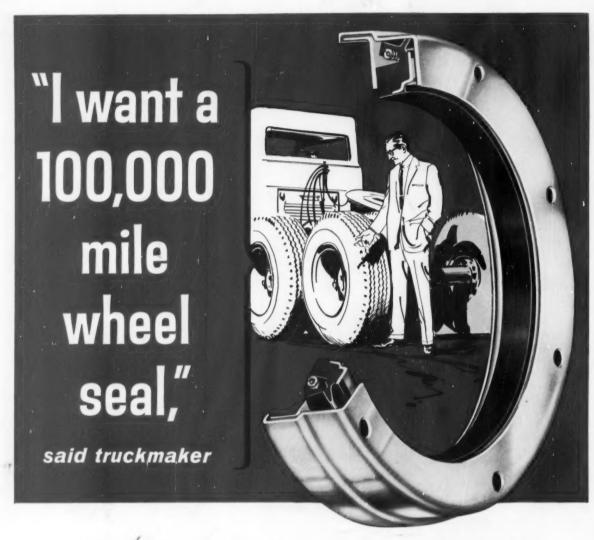
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KEYS TO ADEQUATE LUBRICATION

—wherever you see the sign of Farval—familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated.





"Here's Scotseal," said C/R

Premature wheel oil seal failure—often within the warranty period—was plaguing a major truck manufacturer. This was costly. One seal replacement took three hours labor and three hours tractor downtime—important money to the maker, dealer and buyer. Then C/R found an answer to the problem. A unique, new design called the C/R Scotseal* was submitted and tested . . . then tested again and again. First result: C/R Scotseals repeatedly ran 100,000 miles and more with no sign of failure. Second result: they're approved now for every truck tractor this manufacturer makes.

Just why does this seal go 100,000 miles? C/R developed

a special, ideal sealing surface and made it integral with the seal. The lip runs on this surface, not on the shaft or bore. In operation, centrifugal force creates positive, constant contact for leak-free performance. Also, the seal lip is completely encased and pre-lubricated, protecting it against damage in handling and assembly. This remarkable seal merits your consideration wherever high production runs are involved; where oil retention is difficult; and where equipment downtime and replacement costs are critical. The savings it can afford you and your customers may far outweigh the additional cost of this top-quality seal.

Write for your copy of C/R Scotseal* Bulletin SS-100.

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*Reg. U. S. Pat. Off

